Spring 2020

PROCEEDINGS 2020, THE NEBRASKA ACADEMY OF SCIENCES

Nebraska Academy of Sciences

PROCEEDINGS

THE NEBRASKA ACADEMY OF SCIENCES

1880-2020

Including the

Nebraska Association of Teachers of Science

(NATS) Division

Nebraska Junior Academy of Sciences

(NJAS) Affiliate

and

Affiliated Societies

140th Anniversary Year

One Hundred-Thirtieth Annual Meeting

THE NEBRASKA ACADEMY OF SCIENCES, INC.

302 Morrill Hall, 14th & U Streets
Lincoln, Nebraska 68588-0339
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Affiliated with the American Association for the Advancement of Science
And
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GENERAL INFORMATION

The Nebraska Academy of Sciences was organized on January 30, 1880 with monthly scheduled meetings in Omaha, Nebraska. The Academy was reorganized on January 1, 1891 and annual meetings have been held thereafter.

AUTHORS ARE INVITED TO SUBMIT MANUSCRIPTS OF THEIR WORK FOR PUBLICATION IN THE *TRANSACTIONS* OF THE NEBRASKA ACADEMY OF SCIENCES, a technical journal published periodically by the Academy for 48 years.

Articles in all areas of science, science education, and history of science are welcomed, including results of original research as well as reviews and syntheses of knowledge.

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NEBRASKA ASSOCIATION OF TEACHERS OF SCIENCE (NATS)

The 2020 Fall Conference of the Nebraska Association of Teachers of Science (NATS) will be held at the Younes Conference Center, Kearney, NE, October 1-3, 2020.
President: Anya Covarrubias, Grand Island Public Schools, Grand Island, NE
President-Elect: Scott King, North Platte Public Schools, North Platte, NE

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5. **Nebraska Geological Society**
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   Sponsors of a $50 award to the outstanding student paper presented at the Nebraska Academy of Sciences Annual Meeting, Earth Science /Nebraska Chapter, Nat'l Council Sections

6. **Nebraska Graduate Women in Science**

7. **Nebraska Junior Academy of Sciences**
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11. **Nebraska Space Grant Consortium**
    Web site: http://www.ne.spacegrant.org/

PROCEEDINGS

AERONAUTICS AND SPACE SCIENCE

INVERSE KINEMATIC ANALYSIS AND CONTROL SYSTEM DEVELOPMENT FOR REMORA ROBOTIC ARM

Nathan Jensen, Department of Mechanical and Materials Engineering, University of Nebraska Lincoln, NE, 68588

The common contemporary use of small satellites in applications from planet-monitoring devices in Earth orbit to communication relays sent to Mars creates both opportunities and challenges. Any new technology that has a significant impact in this industry will take advantage of the former while addressing the latter. REMORA is a device that does exactly that. REMORA is a robotic arm designed and built at NASA Jet Propulsion Laboratory, and is intended to support arm-to-arm docking and object grasping in low Earth orbit. REMORA will be deployed onboard small satellites, allowing for the construction of large arrays made of small spacecraft, as well as debris management through rendezvous with and grasping of orbiting objects. Until recently, each of REMORA's five joints could only be controlled individually. Kinematic analysis was performed in order to solve for all joint angles simultaneously given a target position for the arm's end effector. This was done by observing that the last three joint axes are parallel, and thus can be solved in a planar fashion once the first two, closest to the base, are determined. A general inverse kinematic solution set was then created in such a way that an end point and direction for the final link could be specified, and the arm could pose accordingly. This was then transferred to a self-contained control system so that REMORA's motion could be demonstrated, allowing for further development and testing in the future.

PERFORMANCE METRIC EVALUATION AND PATH PLANNING FOR A 6-DOF 3-LEG PARALLEL ROBOT IN RRRS CONFIGURATION

Nathan Jensen and Carl Nelson, Department of Mechanical and Materials Engineering, University of Nebraska Lincoln, NE, 68588

Parallel robots, mechanisms in which several kinematic chains support a single end effector, have been improved through recent developments in leg architecture. These improvements have increased workspaces, enhanced manipulability, and reduced the number of legs while maintaining the degrees of freedom (DOF) that can be used in end effector control. One recently presented 3-leg configuration is being studied to characterize its performance. This configuration is powered by two rotational joints at the base of each leg, arranged to control the leg through a 2-DOF differential gear train. In the middle of each leg is an unpowered rotational joint, forming its "elbow", and the end of the leg meets the end effector at a 3-DOF spherical joint. An inverse kinematic solution for the system was found, and a method for cancelling out the passive joint from the kinematics was developed. This was used to find a general form of the manipulator's Jacobian matrix, which allows for study of the end effector's manipulability and torque requirements for the robot. A method for path planning on a desired trajectory through the workspace was developed as well, allowing for transformation between the end effector's motion in Cartesian space and the motion of the motors in joint space. When considered together, this work allows for a better understanding of the robot's performance and opens the door for operating its prototype.

DRAG REDUCTION/ENHANCEMENT USING FEMTOSECOND LASER SURFACE PROCESSING

Henry Ems and George Gogos, Department of Mechanical and Materials Engineering; Aaron Ediger, Alfred Tsubaki, Craig Zuhlke, and Dennis Alexander, Department of Electrical and Computer Engineering; and Mahdi Mohammadi-Ghaleni and Siamak Nejati, Department of Chemical and Biomolecular Engineering, University of Nebraska-Lincoln, NE 68588

We will present methods for enhancing or reducing drag experienced by metallic surfaces (304 stainless steel) functionalized with a femtosecond laser. Experiments were conducted with purified water (0.2 μm filtration). Femtosecond laser surface processing (FLSP) was performed on multiple sets of 304 stainless steel plates to produce multiscale self-organized micro/nanostructures. Data were collected at different Reynolds numbers by varying the mass flow rate. Data were recorded after steady state was reached. One set of processed plates were kept superhydrophilic and were used to obtain the friction factor in a rectangular channel test section over Reynolds numbers from 8,000 to 20,000. For a superhydrophilic rectangular channel with microstructures, drag enhancement was measured with respect to smooth (unprocessed) surfaces over the total range of Reynolds numbers tested. A second set of processed plates were coated, in a vacuum chamber, with fluorinated silane using evaporative deposition that made the plates superhydrophobic. The superhydrophobic plates were then tested in the rectangular channel test section to obtain the friction factor. With the addition of an acrylic viewport, the presence of an air layer (plastron) was observed that sheds light to the friction factor data obtained for superhydrophobic plates. Drag reduction was shown for Reynolds numbers that were accompanied with a plastron.

USE OF FEMTOSECOND LASER SURFACE PROCESSING TO CREATE HIGH EMISSIVTY SURFACES

Jace Wieseler, Mark Anderson, Jeff Shields, and George Gogos, Department of Mechanical and Materials Engineering; and Dennis Alexander, Craig Zuhlke, Andrew Reicks, and Alfred Tsubaki, Department of Electrical and Computer Engineering, University of Nebraska-Lincoln, NE 68588

For this research project, femtosecond laser surface processing (FLSP) is applied to the surface of metals to enhance the radiative heat transfer performance. FLSP is a surface processing technique that results in the formation of micro- and nano-scale surface features that alter the optical properties of metals. More specifically, high emissivity surfaces were created that have aerospace applications such as cooling of electronics on satellites, where heat is radiated into space using high emissivity surfaces. The current methods used to produce high emissivity surfaces for thermal management of satellites are paints. However, these paints deteriorate over time, as well as adds weight to the metal. FLSP is a permanent solution to producing high emissivity surfaces for cooling of space electronics because the surface of the original metal is altered at the micro- and nano-scale without the addition of coatings. The goal of this project was to create FLSP structures that result in hemispherical emissivity values comparable or greater than the emissivity values of the paint, which is around 0.9. By varying the parameters of the femtosecond laser, particularly the fluence (J/cm^2) and the number of pulses applied to each area of the sample, different micro- and nano-scale structures are produced that result in increased hemispherical emissivity values, measured in the range of 7.5 μm to 14 μm. Using aluminum, mound-like structures with a thin top layer of oxidized nano-scale structures resulted in the highest hemispherical emissivity, around 0.95. For stainless steel, pyramid-like structures with a thick top layer of oxidized nano-scale structures resulted in the highest hemispherical emissivity, also around 0.95.

USING MULTISPECTRAL DRONE IMAGERY TO MEASURE CHANGES IN VEGETATION COVER IN THE NEBRASKA SANDHILLS: PATTERNS IN SPACE AND TIME

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The Nebraska Sandhills region is one of the largest intact grasslands in North America and provides several key ecosystem services. Consisting of grass-stabilized sand dunes and interlaying wet meadows, the porous soil is largely unsuitable for intensive agriculture, so the primary land use is cattle grazing. Thus, studying grass productivity is paramount in this region as it serves as an indicator for (1) economic viability in that it describes available forage for cattle and (2) vegetative cover that stabilizes the sand dunes. The aim of this project was to measure vegetative response to available water over the landscape and in wet vs. dry periods. Due to the fast draining soil in the dunes, available water is often the limiting factor for grass cover. Our study used high resolution multispectral drone imagery in addition to other remotely sensed and field data to measure vegetative patterns at our study area near the north fork of the Dismal River. Drone data was used to quantify productivity by using the Normalized Difference Vegetation Index (NDVI). Available water was determined using the Standardized Precipitation-Evapotranspiration Index (SPEI) dataset. Our analyses suggest that NDVI values respond to climate conditions as represented by SPEI calculated over the short (<3-month) term. Meteorological data and our observations suggested that spring of 2019 was one of the wettest periods on record. This led to many of the wet meadows being inundated and prevented ranchers from harvesting hay that would typically be accessible. Therefore, it seems that precipitation increases grass productivity on the upland sand dunes in the short term, but periods of longer above-average precipitation (e.g. 48-month SPEI values) cause increases in ground water in wet meadows, which ultimately decreases forage available to ranchers. The complexity in how climate controls vegetation cover in both the short and long-term in the Nebraska Sandhills is integral to understanding the social-ecological system.

DISRUPTING INTER-LIMB COORDINATION THROUGH AN EXOSKELETON DEVICE

Takashi Sado and Mukul Mukherjee, Department of Biomechanics, University of Nebraska at Omaha, NE 68182

Healthy gait requires the two legs to be working in smooth and efficient coordination. However, space travel, and time spend in micro- or macro-gravity can cause disruptions in the efficiency of such coordination during walking. Traditionally, inter-limb coordination has been examined using linear analyses, but these are limited in capturing the dynamics of human movements. Specifically, nonlinear analytical tools like Cross-Recurrence Quantification Analysis (cRQA) and Cross-Sample Entropy(cSE), can characterize how human inter-limb coordination evolves over time. Therefore, in this study, we examined the temporal structure of the inter-limb coordination, specifically how long the two legs were coordinated and how repeatable their gait patterns were. We did this by making healthy human participants walk naturally and the disrupted their inter-limb coordination by using a passive exoskeleton device. Healthy young participants were assigned to either a unilateral exoskeleton group (EXO) or a control group. All participants performed normal walking at their preferred speed. Inter-limb coordination was examined using nonlinear tools, specifically, cRQA and cSE of heel marker kinematics in the sagittal anterior-posterior direction. The results from cRQA shows that although the duration of coordination was shorter and larger phase space was needed in the EXO group, the predictability of inter-limb coordination did not differ between the groups. Higher cSE values in the EXO group indicated that walking with the device decreased the repeatability of the inter-limb coupling. An unpowered exoskeletal device altered inter-limb coordination by reducing its duration and repeatability. In individuals who have altered inter-limb coordination patterns such as patients with sensorimotor deficits or astronauts in altered gravity environments, such devices could be used to drive inter-limb in specific directions to restore health.

ASSESSING LIMB POSITION PERCEPTION WITH AND WITHOUT TACTILE STIMULATION

João Gomes, Takashi Sado, Kyle Brozek, and Mukul Mukherjee, Department of Biomechanics, University of Nebraska at Omaha, NE 68182

There are major concerns facing astronauts after long-duration space missions including muscle atrophy, degradation of balance, and impaired limb proprioception. Due to the altered gravity environments astronauts experience, their ability to perceive body position is impacted. Perception of the limb position and orientation whether the limb is held in a static position or is in motion, is fundamentally important for astronauts to efficiently carry out manual tasks in space. However, it is not clear how this important perception can be tested in space or a model of space-related deterioration in body perception be created. The present study analyzed healthy people's perception of their limbs' position with and without tactile stimulation on an isokinetic dynamometer device. Tactors were used to provide tactile stimulation to the joint to determine whether joint position perception improved or deteriorated. The study consisted of one session where participants completed 12 conditions. Joint position perception was tested at the elbow and measured in an active and passive mode, without visual or auditory feedback. For both the active and passive mode, the subjects were also tested with and without tactile stimulation. The subjects were asked to press a button whenever they thought their limb reached a predetermined angle (30, 45 and 60 degrees) which they had previously experienced during practice trials. The results obtained demonstrate how the subjects were able to accurately predict their limb's position in a majority of cases and make corrections over multiple trials of each condition, thus constituting a valid method to assess a person's position perception. Although a deterioration was anticipated in joint position perception during tactile stimulation, for the majority of trials, the participants improved their performance when considering only the first repetition (effect of learning removed), approximating their predictions to the predetermined angle for both the active and passive mode. These findings demonstrate that inputting vibration in a joint may improve perception of the body's position in space, thus representing a possible method for astronauts to counter proprioception degradation. Keywords: microgravity, limb proprioception, vibrating tactors, countermeasure.

EXERCISE AND COLD-INDUCED PGC-1 MRNA ISOFORM-SPECIFIC RESPONSE

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Cold exposure with aerobic exercise stimulates gene expression of PGC-1, the master regulator of mitochondrial biogenesis. PGC-1 can be expressed as multiple isoforms. Among these isoforms is NT-PGC-1, which produces a truncated form of the PGC-1 protein, as well as isoforms derived from the first exon of the transcript. Relatively little is known about the specificity and response of these isoforms to environmental temperature and aerobic exercise. Purpose: Determine the expression of PGC-1 isoforms following an acute bout of cycling in cold and room temperature conditions. Methods: 9 male participants cycled for 1 hour at 65% Wmax in -2 and 20 °C. A muscle biopsy was taken from the vastus lateralis pre and 3h post exercise. qRT-PCR was used to analyze gene expression of PGC-1 isoforms expression. Results: Gene expression of all isoforms increased due to the exercise intervention 3h post exercise ($p < 0.05$). At 3h, total-PGC-1 was higher in the cold (3.5 ± 0.6 fold increase) compared to room temperature (2.9 ± 0.4 fold increase, $p = 0.028$). NT-PGC-1 was also higher in cold (4.1 ± 1.1 fold increase) compared to room temperature at 3h (3.4 ± 0.4 fold increase, $p = 0.034$). Gene expression of exon 1 isoforms was similar in room temperature and cold conditions at 3h post exercise ($p > 0.05$). Conclusions: Exercise and cold exposure induced alterations in gene expression for total-PGC-1 and its truncated isoform, NT-PGC-1, but there was no temperature-dependent response in the other PGC-1

isoforms measured. It appears that NT-PGC-1 contributes to the upregulation of total-PGC-1 transcripts measured in the exercise-induced PGC-1 response.

DIETARY NITRATE INTAKE IMPROVES VASCULAR FUNCTION AND WALKING CAPACITY IN PATIENTS WITH PERIPHERAL ARTERY DISEASE

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Peripheral artery disease (PAD) is the manifestation of atherosclerosis in the arteries of the legs, which reduces blood flow to the lower extremities and impairs walking capacity. Dietary nitrate (NO_3^-) has been used to reduce blood pressure (BP) and increase exercise tolerance in PAD. However, a standard dose, body mass normalized NO3-, for PAD has yet to be determined. The purpose of this study was to elucidate the impacts of a body mass-normalized dose of NO3- (0.11 mmol NO_3^-/kg) in the form of beetroot juice on resting heart rate (RHR), central and peripheral BP, vascular function, and exercise tolerance in patients with PAD. In a randomized crossover design, 10 patients with PAD (stage II-III) received either the NO_3^- supplement or placebo. At each visit, measures of RHR, central and peripheral BP, brachial and popliteal artery endothelial function (flow-mediated dilation, FMD), arterial stiffness (pulse-wave velocity, PWV; augmentation index, AIx), maximal walking capacity, and time to claudication (COT) were measured before and after NO_3^- and placebo. There were significant group by time interactions (p<0.05) for systolic BP, endothelial function, and maximal walking distance. Systolic BP was significantly reduced (p<0.05) while popliteal FMD, brachial FMD, and maximal walking distance significantly increased (p<0.05). NO_3^- intake reduced central systolic BP and increased maximal walking time (p<0.05). There were trends for decreased diastolic BP (p=0.15), central diastolic BP (p=0.06), and central pulse pressure (p=0.17). There were no changes in RHR, deceleration time, max dP/dt, carotid-to-radial PWV, carotid-to-femoral PWV, carotid-to-ankle PWV, AIx, or COT (p>0.05). These results indicate that a dose of NO_3^- (0.11 mmol NO_3^-/kg) seems to be an effective dose for improving BP, vascular function, and walking capacity in patients with PAD.

CHANGES IN MUSCULAR RESPONSE TO SUPERVISED EXERCISE THERAPY

Hafizur Rahman and Sara Myers, Department of Biomechanics; and Gnapika Talluri, Department of Mathematics, University of Nebraska at Omaha, NE 68182. Iraklis Pipinos and Jason Johanning, Department of Surgery, University of Nebraska Medical Center, NE 68198.

Muscle atrophy is a common problem for astronauts while traveling and stationed at the International Space Station due to the microgravity environment. Although several specific exercise countermeasure devices (i.e. weighted treadmill, advanced resistive exercise device) have been developed, astronauts still experience significant deficits in muscle function upon returning to earth. The contribution of these countermeasures to muscle function and muscular responses is not well understood. The purpose of this study is to implement musculoskeletal computational modeling and simulation to investigate how exercise countermeasures impact muscle function by quantifying the typical muscular force response to exercise. An ideal population to test the effectiveness of countermeasure will be individuals with peripheral artery disease as they show similar kind of deficiency in calf muscles as astronauts. Patients with peripheral artery disease recruited for this study participated in a 6-month supervised exercise therapy program that followed the American College of Sports Medicine Recommendations. Gait kinematics and kinetics data during overground walking trials was collected before (baseline) and after the supervised exercise therapy program (post-exercise). The experimental data was imported into a biomechanical modeling software OpenSim that can simulate the gait performance. Outcome variables were normalized by bodyweight (BW). Preliminary results of 1 subject showed that the peak ankle torque increased 5.40% after exercise during push-off phase of gait

cycle (baseline: 1.36 N-m/Kg, post-exercise: 1.43 N-m/Kg). Although peak medial gastrocnemius force decreased 9.57% compared to baseline (baseline: 2.34 BW, post-exercise: 2.12 BW), but peak soleus muscle force increased 28.73% after exercise (baseline: 1.55 BW, post-exercise: 2BW). These primary results suggest that the walking performance and calf muscle strength are improved after exercise. Comparing these outcomes in significant number of subjects will provide a better understanding of how muscle function improves following supervised cardiovascular exercise and correlates to several gait variables. This fundamental knowledge could be useful for future modifications of exercise countermeasures and rehabilitation protocols for astronauts on International Space Station and upon returning to earth as well.

EFFECT OF VITAMIN D SUPPLEMENTATION ON BALANCE IN INDIVIDUALS WITH CHRONIC KIDNEY DISEASE: A PILOT STUDY

Alissa Miller and Jennifer M. Yentes, Department of Biomechanics, University of Nebraska at Omaha, NE 68182

Spaceflight contributes to muscle atrophy and loss of bone mass due to microgravity and space radiation. During spaceflights, high amounts of calcium are broken down and released into the blood stream, reflected in the decrease of bone density. As a result of these and other physical changes, astronauts experience balance deficits upon return to Earth; sometimes taking months or even a year to get back to pre-flight levels. Thus, the purpose of this study is to determine if vitamin D supplementation will to lessen balance deficits upon return to Earth. Patients with end stage renal disease (ESRD) also experience similar changes (ie, muscle wasting, weakness, decreased balance, increased fall rates, and vitamin D deficiency). Therefore, we used patients with ESRD as a surrogate to astronauts upon return from spaceflight. Subjects performed a series of balance tests at baseline. They were then given a 3-month supply of vitamin D (either a standard dosage or high dosage). After 3 months of vitamin D supplementation, subjects returned to the laboratory for post testing. Static and dynamic balance was measured using the Neurocom Balance Manager system: the Sensory Organization Test (SOT) and the Motor Control Test (MCT). Preliminary results for the SOT, show that normative mean scores for persons aged 20-59 years is 79.8% and for 60-69 years is 77.6%. All the subjects fell below the normative level for their age group. For almost all translations of the MCT, the subjects had a longer latency as compared to the norm. It is likely that these balance deficits exist due to alterations in sensory and muscular systems associated with the disease.

FUNCTIONAL AND COORDINATION OUTCOMES OF AN 8-WEEK INTERVENTION USING A 3D PRINTED PROSTHESIS: A CASE STUDY

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By the year 2050, it is expected that 3.6 million people will have upper limb amputations[1]. Despite the increase in functionality provided by prostheses, a recent study found that 45% of children with upper limb deficiencies reject their prosthetic device[2]. Training paradigms for acquired amputees and stroke survivors focus on interlimb transfer paradigms to transfer motor repertoires from the non-affected limb to the affected limb[3,4]. This dynamic approach provides useful tools for the assessment of limb coordination and associated variability[5] especially when examining inter-limb coordination and gross manual dexterity[6], which could be translated to intervention programs for astronauts attempting to recover from the effects of microgravity. Thus, the purpose of this study is to assess temporal synchrony of hand movement and gross manual dexterity after completing an 8-week home intervention. Box and Block and bimanual coordination assessments were performed at baseline and 3 months after the start of the study. The bimanual task will require the participant to perform a novel

reaching task uni-manually and bimanually while temporal synchrony and interlimb coordination is measured. Based on previously reported data and preliminary results, the anticipated results of this study include an increase in temporal synchrony while completing the bimanual coordination test and an increase in blocks transferred in the box and block test. The 8-week intervention program will ensure the repetition of reaching movements is completed by the research participant while using a 3D printed prosthesis and non-affected arm. Increasing prosthetic home usage will create better outcomes in bimanual and gross manual dexterity motor assessments.

3D PRINTING OF ADVANCED CERAMIC MATERIALS FOR SPACE APPLICATIONS

Xiang Zhang, Sam Ruiz, Kevin Zhao, and Bai Cui, Department of Mechanical & Materials Engineering; and Yongfeng Lu, Department of Electrical and Computer Engineering, University of Nebraska–Lincoln, NE 68588

Our team is developing novel laser 3D printing processes to fabricate structures using advanced ceramic materials for space applications. High-energy laser beam has been used to heat and sinter ceramic powders to fabricate ceramics with a high density, few defects, and high mechanical properties. This presentation shows an example of our research on the successful fabrication of barium titanate ($BaTiO_3$) ceramics by a direct selective laser sintering (SLS) process. The phase composition and microstructures were analyzed by X-ray diffraction, neutron diffraction, and electron microscopy. A crack-free $BaTiO_3$ layer can be formed by SLS, which has a thickness of 500 μm, grain size of 80 to 180 μm, and a relative density higher than 97%. The densification mechanism in the LPS process was discussed.

SPONTANEOUS CORTICAL ACTIVITY IS ASSOCIATED WITH SENSORIMOTOR CORTICAL OSCILLATIONS

Michael P. Trevarrow, Tony W. Wilson, and Max J. Kurz, Department of Physical Therapy and Center for Magnetoencephalography, University of Nebraska Medical Center, NE 68105

A series of well-known oscillatory responses have been documented that are elicited surrounding motor actions. Prior to movement, there is a beta event-related desynchronization (ERD), which is thought to reflect motor planning. At movement onset, there is a synchronization in the gamma band, termed gamma event-related synchronization (ERS), that reflects movement execution. Finally, after movement, there is a post-movement beta rebound (PMBR), which reflects movement termination. While each of these responses has been well connected to different processes surrounding movement control, little is known about the baseline (spontaneous) cortical activity and how it may be related to the strength of the motor-related oscillatory responses. In the current study, magnetoencephalography (MEG) was used to assess the power of these oscillatory responses and spontaneous cortical oscillations as a cohort of adolescents ($N = 83$, Age = 11.67 ± 1.57 years) underwent a simple motor task. Beamforming methods were then used to image the oscillatory source power changes across the entire brain volume. From these brain images, we extracted pseudo-t values from the peak voxel (cube of tissue) of activity to assess the magnitude of the respective responses (i.e. the beta ERD, gamma ERS, and PMBR). Our results indicated that spontaneous cortical activity was significantly associated with the strength of the beta ERD ($r = -0.56$, $P < 0.001$), the gamma ERS ($r = -0.43$, $P < 0.001$), and the PMBR ($r = -0.29$, $P = 0.015$). We suggest that the power of the oscillatory responses surrounding motor control are modulated by an individual's spontaneous cortical activity. This information is critical as deviations in spontaneous activity may have adverse downstream effects on motor-related oscillations and motor control. Assessment of spontaneous cortical activity may be utilized as a neurophysiological index to predict how sensorimotor functioning is affected when astronauts return from space.

DECIPHERING THE WORKINGS OF THE RADIATION-PROTECTIVE ENZYME HUMAN MANGANESE SUPEROXIDE DISMUTASE

Jahaun Azadmanesh, William E. Lutz, Kevin L. Weiss, Leighton Coates, and Gloria E. O. Borgstahl, Department of Biochemistry and Molecular Biology, University of Nebraska Medical Center, Omaha, NE 68198

As humanity aspires to embark for interplanetary travel to Mars and further trips to the moon, astronauts from past Apollo missions have been showing the long-term disease effects of deep space exposure. Apollo lunar astronauts are exhibiting high levels of oxidative stress leading to cardiovascular-related mortality rates five times that of non-flight astronauts. Future space travel entails mitigating deep space radiation to preserve the cardiovascular health of those venturing towards new frontiers. Human manganese superoxide dismutase (MnSOD) is the major antioxidant enzyme that protects the mitochondria from oxidative stress by performing concerted proton and electron transfers (CPETs) to minimize levels of harmful reactive oxygen species (ROS), especially those from radiation. Because the modulation of ROS levels within the mitochondria is central to programmed cell death and its altered workings in cancer and cardiovascular diseases, deciphering the means of how MnSOD employs the use of CPETs is paramount to understanding both disease progression at an atomic/subatomic scale as well as designing therapeutic interventions for astronauts. To directly detect proton and electronic states of MnSOD, we have used a combination of techniques inclusive of a novel experimental application that permits the first direct visualization of MnSOD's protons, neutron crystallography.

THE EFFECT OF PLANTAR VIBROTACTILE STIMULATION ON THE LOCOMOTIVE ADAPTABILITY OF OLDER ADULTS WHEN NEGOTIATING MULTIPLE OBSTACLES

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The ability to adapt to environmental obstacles is crucial to successful locomotion, and for people who are experiencing decreased sensation for medical reasons, or astronauts in environments of partial weightlessness, the lessened ability to sense the position of their body in space may hinder successful locomotion. We hypothesized that vibratory stimulation on the soles of older adults' feet would result in an altered strategy for negotiating multiple obstacles when compared to the strategy used without vibratory stimulation. Ten healthy adults (60-70 years old) had ten retro-reflective markers placed on bony landmarks. Participants stepped over two obstacles (10% of participants' height) placed three steps apart. They completed 5 trials without vibration and 5 trials with vibration at a supra-threshold frequency-amplitude of 250Hz and 17.5db at normal walking speed. Kinematic data of four gait events were recorded: maximum toe elevations (MTE) of the leading leg and trailing leg when clearing an obstacle, and distance of heel strike and toe-off from the obstacle of the leading leg and trailing leg respectively. The MTE was normalized by the height of participant. A significant difference between no vibration and supra-threshold vibration for MTE the leading leg crossing over the second obstacle ($p < 0.01$) was recorded. The mean MTE crossing over the first obstacle was 0.115 cm (95% CI: 0.104-0.125) and the second obstacle was 0.118 cm (95% CI: 0.107-0.129). No difference was observed between two obstacles or two vibration conditions with heel strike, toe off, or MTE of the trailing leg. The change in MTE of the trailing leg indicates an alteration in walking strategy as a result of stimulation. With stimulation, participants lifted their legs up higher when crossing over the second obstacle. This increased room to maneuver between the participant's foot and the obstacle may indicate more successful negotiation of the obstacle.

DEVELOPMENT OF GRAVITY-DRIVEN, COMPACT LIQUID DROP GENERATOR

Stephanie Vavra, Haipeng Zhang, and Sangjin Ryu, Department of Materials and Mechanical Engineering; and Charles Riedesel, Department of Computer Science and Engineering, University of Nebraska-Lincoln, NE 68588

Liquid drop generation is an everyday phenomenon to which many people are exposed to daily. From dripping water faucets to liquid metal droplet generation, many people are particularly familiar with various cases of three-dimensional (3D) drop formation. Conversely, less is known about gravity-driven, two-dimensional (2D) liquid drop formation and its important applications such as interplanetary soil collection, high-power space station liquid drop radiators, and even fluid dynamics education. Hence, research on gravity-driven, 2D drop formation was conducted and microfluidic devices mimicking the phenomenon were developed. In previous research in Dr. Sangjin Ryu's Bio/Flow Research Laboratory, a liquid toy timer which demonstrated the 2D drop formation phenomenon was studied to understand its unique 2D drop formation process. This toy timer is the basis of our gravity-driven liquid drop generation device design which has been used for prototyping a functional device for practical application. Using different fabrication methods and including materials such as polydimethylsiloxane (PDMS) and acrylic, multiple prototypes were fabricated to mimic the properties found within the toy timer. With a high-speed camera and MATLAB program previously made in collaboration with Dr. Charles Riedesel, the liquid drop characterization was analyzed within the different prototypes and compared to the results of the liquid toy timer tests. Fluid drop generators currently being used are often large and complex, this research provides insight for a more compact and simpler drop generator system. Furthermore, additional research can be conducted for the fabrication of a complete system for interplanetary exploration.

DO EMOTIONAL FACTORS AFFECT TASK PERFORMANCE RELEVANT TO NASA MISSIONS?

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Successful space missions are an extremely important part of NASA's goal of space exploration. Yet, these missions can be highly stressful for astronauts as they face alternating periods of social isolation and extreme social proximity during spaceflight. Due to this stressful setting, astronauts may be at increased risk for chronic stress and loneliness. In turn, these factors may not only negatively impact mission success, but could also result in poor health outcomes for the astronauts because loneliness is a key factor linked to greater morbidity and mortality. The primary objective of this project is to investigate how performance on cognitive and emotional tasks that are relevant to NASA missions is associated with stress and loneliness. These results will set the stage for determining specific emotional factors linked to task performance in settings relevant to space missions. Furthermore, a secondary objective is to examine the role of other relevant emotional factors, such as empathy. This project utilized a multi-method approach to assess stress, emotion, and cognition through communication analyses, questionnaires, behavioral measures, and biomarkers (i.e., salivary assays). Participants included healthy, community dwelling adults ranging in age from 19-90 years. We found that variability on task performance was associated with emotional measures and salivary hormone levels. This study is a first step towards understanding emotional and biological factors that affect task performance relevant to NASA missions, and overall emotional well-being. Future studies may examine the impact of these factors on task performance and well-being in a simulated space environment.

THE EFFECTS OF TEAMWORK ON VERBAL OUTPUT IN INDIVIDUALS WHEN COMPLETING TASKS OF VARYING MENTAL AND PHYSICAL EXERTION

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Communication is an integral component when individuals work together to complete teamwork tasks. The purpose of this study was to explore the influence of teamwork on one's verbal expression and one's self-perception of teamwork. Data from eighteen adults divided into six groups of three were used in this study. Participants were healthy adults and native English-speakers. Individuals were administered a self-esteem, temperament, and sociability questionnaire before completing the teamwork tasks. Varying task difficulty was measured by the total amount of time it took to complete a given assignment by the experimenters before the study began. During the experiment, tasks included both individual tasks and teamwork tasks. A language sample was gathered to indicate participants' verbal expression during the teamwork task and during a post-task interview. Results indicated no significant correlation on the impact of a more difficult last task (an individual task) on one's verbal expression during the teamwork task. With respect to verbal output during the task and post-task interview, results showed that verbal output of participants during the tasks was significantly correlated to verbal output during a one-on-one interview post task. One may conclude that leaders of verbal expression carry their expressivity to other communication contexts. This study also evaluated individual self-perceptions of teamwork and how it impacted verbal expression during the teamwork tasks. Participants' self-perceived teamwork scores and verbal expression during the teamwork tasks was positively and significantly correlated. One who enjoys working in a team may express more verbally and others who may not enjoy working as a team may restrict their verbal expressions.

QUASAR ACCRETION DISK VARIABILITY FROM SIMULATIONS AND SLOAN DIGITAL SKY SURVEY DATA

Alan Roden and Jack Gabel, Department of Physics, Creighton University, Omaha, NE 68178

The main goal of this research project is to investigate the accretion mechanism that powers the enormous luminosities of quasars by developing and analyzing simulations of black hole accretion. The strategy in investigating this topic is comparing our simulations of the variability of accretion disk emission with data in the Sloan Digital Sky Survey (SDSS) database. The dataset consists of about 9000 targets and our analysis includes 5000 target quasars from Stripe 82 and includes variability data observed in all five optical bands. We compare these data with our simulations which predict emission variability in the accretion disk in different filters as well as using a wavelength and radial dependence. We present initial results of these simulations and the implications of the nature of quasar accretion disk emission. Next steps include expanding on the range of the electromagnetic spectrum that is investigated, such as infrared and ultraviolet radiation.

TESTING QUASAR OUTLOW MODELS USING THE SLOAN DIGITAL SKY SURVEY QUASAR CATALOG

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Quasar accretion disk winds driven by ultraviolet radiation from the inner regions of the disk constitute a leading theoretical model for the broad absorption lines observed in quasars. This investigation provides a crucial test of the kinematic and geometric parameters associated with these accretion disk wind models with respect to quasar orientation, a major expected contributor to the differences observed in various quasar spectra. Simulated absorption spectral profiles are compared to observed broad absorption line parameters using data from the Sloan Digital Sky Survey. Principal

component analysis performed on both the simulated and observed data reveals strong similarities between the two, indicating the radiation-driven wind model agrees with the observations of the Sloan Digital Sky Survey with respect to quasar orientation.

CAN QUASAR OUTFLOWS BE ACCRETION DISK WINDS?

Margaret Johnston, Department of Physics, Creighton University, Omaha, NE 68178

Quasars, or active galactic nuclei, are the galactic supermassive black holes which are currently observed to be accreting matter and emitting light. They have intense luminosities from the infalling gas of the accretion disk as its gravitational potential energy is converted to light. Quasar outflows are gas which is being ejected away from the central supermassive black hole evidenced by blueshifted absorption lines in the UV and X-ray portions of the spectrum. According to the accretion disk wind model, these outflows originate at very small distances from the black hole and are driven from the system by radiation pressure. One serious challenge to this model is that the best available measurements suggest a prohibitively large distance is necessary for these outflows to exist. The photoionization modeling code Cloudy is used to simulate these outflows and is able to vary such physical parameters as the total luminosity of the quasar, the spectral shape, and the gas density to provide simulated total ionic column densities for the modeled gas. An extensive grid of photoionization models are run to determine which combination of parameters can reproduce the best available measurements in the literature while assuming the small distances of the accretion disk wind model. The parameter combinations which fall within the accepted ranges are analyzed and the implications for accretion disk wind models for quasar outflows are presented.

DETECTABILITY OF BINARY SELF-LENSING SUPERMASSIVE BLACK HOLES

John O. Dancewicz Helmers and Jack Gabel, Physics Department, Creighton University, Omaha, NE 68178

Binary Supermassive Black Hole (SMBH) pairs can form during a galaxy merger event, so it is likely that at least some of the galaxies and active galactic nuclei (AGN) that we observe host a binary pair. These binary pairs may produce a gravitational self-lensing effect that are observable under certain conditions. With the next generation of sky survey projects, such as the Large Synoptic Survey Telescope (LSST), lensing events from binary SMBHs could lead to new information on the inner structure of SMBH and AGN. We formulate a prediction of the total number of lensing events we might see in a given population of AGN. Ultimately, we want to use this to aid in the search for lensing events in existing data and future research.

TURBULENCE DYNAMICS OF DILUTE POLYMER SOLUTIONS OVER SLIP SURFACES

Ethan Davis and Jae Sung Park, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, NE 68588

The addition of small amounts of long-chain polymers to fluids has long been used for the reduction of skin-friction in shear flows. The behavior of these dilute polymer solutions can differ in many ways from typical Newtonian fluids. One important way in which these complex fluid flows can differ is in their slip behavior at the wall. Polymer solutions are among several classes of complex fluids that display behavior inconsistent with the no-slip assumption. Understanding boundary conditions at the wall plays a vital role in correctly predicting drag reduction. Additionally, the presence of surface roughness or low surface energy coatings that are often used for drag reduction can alter these behaviors further. Therefore, the current study performs direct numerical simulations to investigate the effect of slip surfaces (i.e. surfaces that induce a non-zero velocity at the wall) on dilute polymer solutions in

a turbulent channel flow with the goal of better understanding the dynamics of this class of fluids and providing insight into the mechanisms associated with drag behavior. Results indicate a non-trivial drag behavior when a homogeneous slip surface is imposed at the walls of a dilute polymer solution flow. For a given non-zero slip length, skin-friction initially increases before decreasing as the polymer flexibility (i.e. Weissenberg number) is increased. In this talk, the dynamics of these unique flows and the underlying mechanisms responsible for their drag behavior will be explored and discussed further.

LIGHTWEIGHT, MULTIFUNCTIONAL COMPOSITES FOR AEROSPACE THERMAL MANAGEMENT APPLICATIONS

Ethan Krings and Eric Markvicka, Smart Materials and Robotics Laboratory, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, NE 68588

Lightweight, multifunctional composites have played a vital role in the advancement of the aerospace industry. New composite materials will be needed to meet the ever-increasing demands of in-space thermal management systems. Due to the vacuum environment in space, conduction is the primary method for heat transfer for internal spacecraft components. However, current limitations of existing composites include trade offs between thermal conductivity and stiffness, high mass density, risk of component failure, and lack of material programmability. Recently, liquid metal (LM) microdroplets have been incorporated into polymers by mechanically mixing to create composite materials that exhibit exceptional thermal properties, are electrical insulating even at high volume loading, and offer low material stiffness (< 100 kPa). However, the high density of the LM inclusions (6.25 g/cm3) significantly increases the density of the composite, which is problematic for weight sensitive applications such as large-area thermal management. To overcome these limitations, a new low-density, Ga-based liquid-phase filler has been developed to enable a unique combination of properties including high thermal conductivity ($k > 4$ W/m·K), low mass density ($\rho < 3$ g/cm3), and material stiffness ranging from highly compliant elastomers (Young's modulus $E < 1$ MPa) to rigid polymers ($E > 1$ GPa). A lightweight, polymer composite could fulfill a variety of thermal management applications throughout the aerospace industry such as electronics coatings, thermal control surfaces, and thermal protection system adhesives.

MANIPULATING NONLINEAR ABSORBERS TO ENHANCE VIBRATION SUPPRESSION IN HIGH-ASPECT-RATIO WINGS

Heath A. Van Heuveln and Keegan J. Moore, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln at Lincoln, NE 68508

The overall efficiency and performance of commercial airliners must increase to reduce their environmental impact. One approach is to enhance the aerodynamic performance of current aircraft designs using high-aspect-ratio (HAR) wings. However, the increase in aerodynamic performance gained by HAR wings is often offset by significant increases in the amplitudes of vibration that the wing experiences during flight. This research proposes a broadband vibration mitigation strategy for HAR wings by manipulating nonlinear absorbers to dissipate energy at multiple frequencies. Unlike traditional wings, HAR wings exhibit significant motion in both out-of-plane and the in-plane directions. In this research, a model HAR wing is studied computationally using a linear finite element model without any absorbers. Based on the linear vibrational behavior, several absorbers are investigated for use in mitigating the vibrations of the HAR wing including clearance and vibro-impact nonlinear energy sinks and impact absorbers. Based on the computational studies, a vibration mitigation strategy is developed and proposed for a representative experimental system.

DESIGN OF SMART AUTONOMOUS AERIAL ROBOTIC VEHICLE

Andrew Hossack, Andrew Wiedenman, Gerson Uriarte, and Khawm Mung, College of Engineering, University of Nebraska-Lincoln, NE, 68588

The International Aerial Robotics Competition is the longest running collegiate aerial robotics challenge in the world. The most recent mission, Mission Nine, challenges teams to develop a fully autonomous, smart aerial system to meet competition requirements, including real time object avoidance with computer vision, navigation, telemetry, and extremely fast, precise flight. The team at the University of Nebraska-Lincoln (UNL) aimed to develop an unmanned aerial vehicle (UAV) and accompanying software systems capable of completing the challenge under nine minutes sharp. A software system capable of continuous object avoidance, image recognition, smart navigation, and precise flight control will be developed using a NVidia Jetson Nano (a mobile powerful computer) running the emerging technology Robotic Operating System (ROS). The system will also compile, process, and interpret data from multiple sensor output pipelines. These sensor output pipelines include radio communication antenna, high depth perception multi-camera system for visual recognition, and sensors mounted at various points on the UAV to track and avoid obstacles while having minimum blind spot. The hardware design process includes mounting a dipole module to a moving object, robotic manipulation and swapping of a simulated payload, and structural design of the frame. The design challenge was broken down into three main projects each accordingly to meet the functional requirements. For the frame, an octocopter layout was chosen to handle carrying and manipulating a payload of 12 pounds and its combined eight rotors give optimized flight speed. Other factors such as motor and electronic speed controller (ESC) combination, battery size and voltage, and propeller pitch and length were also considered to design a robust power-efficient system.

DESIGN AND CONSTRUCTION OF A HIGH-POWER ROCKET AND VIDEO TELEMETRY PAYLOAD

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The UNL Aerospace Club's Husker Rocketry team designs, constructs and flies high-power rockets to accomplish a competition objective. This year, the team is competing in the Intercollegiate Rocket Engineering Competition (IREC) in the 10k Commercial, Off-the-Shelf (COTS) category. The objective is to design a scientific payload weighing at least 8.8 pounds, and transport it to 10,000 feet using a commercially produced rocket motor. For the payload, a camera suite will be ejected from the rocket at apogee and recovered separately from the rest of the rocket. The payload will be ejected out of the rocket by a flight computer that releases compressed springs. The camera suite has two cameras total, one with a 360 degree field-of-view, its footage will be retrieved post-recovery. The second camera will be mounted on a panning and tilting gimbal and transmitting live video footage to a ground station. The gimbal can be operated from the ground. An onboard GPS locator allows a ground team to find the payload after touchdown. Bonus points will be awarded to teams who's payloads fit a CubeSat form factor (10x10x10cm) or up to three CubeSat form factors stacked together (30x10x10cm). The rocket was designed with a diameter of 6 inches (~15cm) to accommodate this form factor. To fit the required recovery hardware and payload, the rocket was designed to be 9.5 feet long. This rocket will be fabricated utilizing body tubes and fins made by rocketry members, from carbon fiber cloth. Additionally, the payload bay will be made in-house using a reinforced, commercially sourced tube. Fiberglass was chosen to be the reinforcement for this tube to maintain radio wave transparency, allowing for uninterrupted communication with operators on the ground.

NASA ROBOTIC MINING COMPETITION: LUNABOTICS

Tyler Heiman, Aaron Norlinger, Ezra Bailey-Kelley, Jorge Gonzales, and Marco Fabietti, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, NE 68588

The competition involves developing a robot with the mission of collecting and depositing regolith samples in extraterrestrial environments. The robot's mass, amount of material collected, power efficiency, autonomy, and the project systems paper are all components that have a point value and are used for determining placement in the competition. A simulated lunar environment with a BP-1 surface layer, obstacles, and a regolith layer, located below the two, are used for competition runs. The robot has size restrictions that make collecting the regolith that is 30cm under the surface and transferring it to a collection bin that sits 50cm above the surface increasingly difficult. The team developed a three-stage material handling system that is comprised of extraction, transfer, and storage systems. The extraction stage uses a belt with mounted 'digging teeth' to it pull material up and out of its path while it extends into the ground. The transfer stage is a conveyor belt used to carry extracted material to the storage hopper. The storage hopper houses material until lifting it to the collection bin to be unloaded. The drivetrain uses two motors to rotate each wheel, resulting in lower drag while turning. Electronic control systems are housed along the side of the hopper the decrease the likelihood of damage due to dust.

LUNAR SAMPLE CORING DEVICE

Evan Griess, Isaac Regier, Benjamin Rude, Trent Wiens, Mark Chontos, Akilah Baxter, Anthony Oddo, Gabriel Clark, Jonathan Izaguirre, Armon Watson, Chad Alexander, and Dr. Carl Nelson, Department of Mechanical Engineering, University of Nebraska-Lincoln, NE 68508

The University of Nebraska-Lincoln Nebraska Engineering Readiness and Design (NERD) Team developed a coring bit, stabilizing device and sample containment mechanism, for lunar surface use, the "Simple Attachment for Removal of Lunar Aggregate Core Cylinders" or SARLACC. This device consists of two main systems, the stabilizing device and the coring bit. The coring bit is 6.0 inches long with a 0.5 inch inner diameter. On the bottom of the bit, the bit flares out to 1.5 inch diameter. This allows for 0.5 inch of space between the drill bit and the drilled walls of the hole. This allows an astronaut to break off the end of a core sample by applying a force perpendicular to the bit, which breaks the sample at the bottom through bending. The stabilizing device features five legs attached to a bearing, seated concentric to the main cylinder of the coring bit so that the bit can move independent of the jig. These legs stabilize the drill. Prototype testing is planned at the Neutral Buoyancy Laboratory adjacent to NASA Johnson Space Center in June 2020.

COLLEGE OF SAINT MARY ELEMENTARY OUTREACH PROGRAM 2019-2020

Chloe Jensen and Dr. Jennifer Grove, Department of Biology, College of Saint Mary, Omaha, NE 68106

The College of Saint Mary (CSM) Elementary Outreach Program provides hands on activities and interactive learning in math and science topics to elementary students (grades K-5) in the Omaha and surrounding areas. This service is provided by CSM students who work in groups to teach the lessons according to Nebraska state science standards, as well as incorporating a fun, hands-on activity to demonstrate and enforce the material. The program works to reach as many students in the Omaha community as possible each year, as well as utilize student volunteers from all majors and backgrounds at CSM. So far, a total of 1545 students were serviced in the Omaha area through the Outreach program since September of 2019. The program reached 808 students in grades K-2 and 739 students in grades 3-5 in the fall semester. Through February of 2020, a total of 193 students have already been served

with 145 in grades K-2 and 48 students in grades 3-5. This results in a total of 1738 students, from 17 different Omaha area schools, that have participated in the CSM Elementary Outreach Program for the 2019-2020 academic year, with more to come in the remaining months of the school year. The program has been found to promote a growing career path, interest in the STEM subjects, and a chance to spark new interests in elementary students. Many area elementary schools do not have the resources to incorporate such activities and this program allows children to experience projects that they can often take home and continue researching. CSM student volunteers from all backgrounds give positive feedback on their experiences and enjoy the opportunity to volunteer their time to benefit the community and seeing how much these activities are enjoyed by all the children involved.

PIPELINE INTO THEORETICAL MATHEMATICS

Griff Elder & Bradley Horner, Department of Mathematics, University of Nebraska at Omaha, NE 68182

At UNO, we are developing a pipeline that accelerates strong mathematics students through our program, opening up opportunities for achievement and research that wouldn't otherwise be available. In this talk, I will discuss this pipeline that for some students begins in high-school, discuss the accompanying collection of on-campus community building activities that simultaneously recruit and support our high achieving students, and discuss some of the outcomes that we have been able to achieve.

COMPARING HOPF ALGEBRAS OF CHARACTERISTIC 0 AND OF CHARACTERISTIC P

Sarah McCarty, Department of Mathematics, University of Nebraska at Omaha, NE 68182

Hopf algebras are simultaneously an algebra and a co-algebra, and they have an associated dual. Algebras with characteristic 0 have addition where adding objects with itself results in a larger sum. Hopf algebras with characteristic 0 have been extensively studied. However, algebras with characteristic p, a prime, have addition where adding objects with itself p times results in a sum of 0. We work to extend results of Hopf algebras with characteristic 0 to those with characteristic p. This includes explicitly describing co-multiplication in the dual space with characteristic p. We also use discriminants on short exact sequences of Hopf algebras of characteristic p to constrain the size of the algebras.

A PSEUDO-METRIC ON ARTIFICIAL NEURAL NETWORKS

Jacob Cleveland and Griff Elder, Department of Mathematics, University of Nebraska at Omaha, NE 68182

Artificial Neural Networks have shown great potential to solve many difficult problems, including image classification, language translation, and medical diagnosis. The main reason for this is that they are quite good for finding patterns in large datasets. However, the internal structure of neural networks is not well understood. We attacked this problem via Topological Data Analysis (TDA), specifically using Persistent Homology, the go-to tool of TDA, and the Discrete Wasserstein Metric to study a potential method of comparison of Neural Networks. Specifically, we define a pseudo-metric on the space of Neural Networks of a specific type. The Neural Networks studied were fully dense and convolutional networks.

ASSESSING THE VIRULENCE OF *PYTHIUM* TO PLANTS GROWN IN POTTING MIX OR CALCINED CLAY UNDER TWO TEMPERATURE REGIMES

Kendra Wiese and Dr. Phyllis Higley, Department of Biology, College of Saint Mary, Omaha, NE 68106

Pythium is a wide-spread pathogen that causes damping off, root rot, and stunted growth in a wide variety of plant species. *Pythium* disease can be a particular problem in greenhouse- and hydroponically-grown plants, and could, therefore, be a limitation to food production on the International Space Station. The virulence of *Pythium* may be affected by environmental conditions such as temperature. Previous research using agar-grown seedlings, indicated that virulence was greater at lower temperatures. The objective of the current research was to see if that trend holds when radish plants are grown in potting mix or calcined clay at 18C or 25C and inoculated with either *Pythium irregulare* or *Pythium ultimum*. Both species had a greater effect on emergence at 25C than at 18C in plants grown in either potting mix or calcined clay. However, foliar symptoms were more pronounced at 18C, compared to 25C in calcined clay-grown plants.

TRANSMISSION OF PYTHIUM ULTIMUM FROM HYDROPONIC SUBSTRATES TO PLANT ROOTS

Hannah Horne and Phyllis Higley, Department of Biology, College of Saint Mary, Omaha, NE 68106

Pythium is a serious pathogen of greenhouse- and hydroponically- grown plants. Substrates contaminated with Pythium can be an important source of infection for these plants. The objective of this research was to evaluate the spread of Pythium from hydroponic substrates to radish (Raphanus raphanistrum) seedlings. Radish seedlings were transplanted to Pythium ultimum-infested or control peat moss or perlite substrates and grown hydroponically. Plants were evaluated for root rot symptoms weekly for four weeks. Initial results showed no disease symptoms associated with either infested substrate. Additional trials are underway to verify the initial results.

THE VIRULENCE OF *PYTHIUM IRREGULARE* AND *PYTHIUM ULTIMUM* AT VARYING TEMPERATURES

Alyssa Anderson and Dr. Phyllis Higley, Department of Biology, College of Saint Mary, Omaha, NE 68106

Pythium is a genus of soil-borne oomycetes that can harm a variety of horticultural plants. *Pythium* prefers moist environments which puts greenhouse- and hydroponically-grown plants at risk. Disease symptoms can vary from discoloration and stunting of roots to more severe effects such as root rot, damping off, or death of the plant. This study used two isolates each of *Pythium irregulare* and *Pythium ultimum*, and evaluated their virulence on four plant hosts under four temperatures (18ºC, 22ºC, 26ºC, and 30ºC). The isolates showed similar pathogenicity in the four hosts, but virulence varied with temperature. Some host-isolate-temperature interactions were found.

ENHANCING THE CURRICULUM: TEACHING CLIMATE CHANGE THROUGH EXPERIENTIAL LEARNING AND COMMUNITY ENGAGEMENT

Dr. Ganesh Naik, Department of Chemistry and Environmental Sustainability, College of Saint Mary, Omaha, NE 68106

The 21st century has seen significant changes in Earth's climate, which is researched and documented by NASA, NOAA and many other scientists working in different disciplines and published

in peer-reviewed scientific articles. At the College of Saint Mary, we are working on integrating climate change science in our curricular and co-curricular activities. A scientific foundation in student's understanding of Earth's atmosphere, climate and its influence on the ecosystem are essential for them to realize that our earth's limited capacity to support all forms of life and to provide for the needs of human society. The NASA Nebraska grant funding used to develop a new experiential learning course titled 'Sustainability in Action' and improve co-curricular activities in the first-year seminar course- 'Science and Sustainability'. Selected students in these courses also had the opportunity to visit NASA Ames Research Center, Yosemite National Park and Redwood Forest in California. They also met a scientist who is working on outer space life explorations. The course work also involved attending different regional sustainability events, conferences and field trips. These experiential learning opportunities allowed them to generate new ideas to organize events on campus through campus student organization- Green Team. This presentation will involve highlights of experiential learning and community engagement activities, learning outcomes and continued challenges in the discussion of climate change and sustainability.

INVESTIGATION OF BIOTIC INFLUENCES ON THE FORMATION OF IRON OXIDES AND THEIR ROLE ON MARS

Kinsley Mason, Department of Natural Sciences, Chadron State College, Chadron, NE 69337

The discovery of hematite spherules on Mars by the twin rovers Opportunity and Curiosity has opened up a discussion on the formation of iron oxide concretions both on Mars and on Earth. Studies have shown that formation of iron oxide concretions could occur under the influence of biotic factors, such as iron-oxidizing bacteria. The conversion of Fe(II) minerals into iron oxide is being meditated by the molecular processes of bacteria. In a controlled laboratory environment these processes can be studied in depth and analyzed. Understanding these processes will allow for a view into the possibility of ancient life on Mars.

POSTERS

ENVIRONMENTAL MONITORING THROUGH NATIVE PRAIRIE RESTORATION

Brook Cayou, Alexander White, Gabriela Medina, Inessa Lyons, Susan Morris, Estelle Farley, Lani Moran-Samqua, Anthony Sharpfish, Kenneth Carufel, Hank Miller & Dasha Weatherman, Department of Math and Science, Nebraska Indian Community College, Macy, NE 68039

This long-term research project compares local weather data from our Nebraska Indian Community College (NICC) Santee and Macy weather stations with biological markers from our Santee and Macy Native Prairie Restoration Projects. Research plots occupy thirteen and fifteen acres respectively. The biological markers come from: satellite images of our research sites, ground level photos, plant inventories, and soil sample analysis. Our native prairie restoration management techniques consist of three consecutive years of spring mowing followed by a spring burning on the fourth year. This management regime will be included in our analysis and correlated with all other data. We hope to gain knowledge about how weather and management techniques influences biodiversity and successional changes along with soil health in our prairie restoration sites.

CLASSIFYING TOTALLY RAMIFIED GALOIS EXTENSIONS OF PRIME POWER ORDER OVER LOCAL FIELDS

G. Griffith Elder and Grant Moles, Department of Mathematics, University of Nebraska at Omaha, NE 68182

This presentation examined totally ramified Galois extensions of order p^4, p an odd prime, over local fields. There are fifteen such Galois extensions, as presented by Burnside. Of the Galois groups of these extensions, five are abelian and ten are nonabelian. Only the nonabelian cases are handled here, since the abelian cases are trivial. These can be classified by determining the Artin-Schreier equations which determine the equations. This is done by using the Weierstrass p function, defined such that $p(x)=x^p-x$. Each nonabelian extension can be examined in this way, first by examining abelian and nonabelian groups of order p^3, then extending these to the desired extensions. Since the elements defining the extensions are non-unique, the definitions presented are non-unique; however, they are selected in such a way that the definitions of similar extensions are similar. Furthermore, the p values of the defined extension elements are such that they each lie in an field extension over the base field of degree no more than p^2.

IDENTIFYING ATTRACTORS IN A LARGE-SCALE DETERMINISTIC MODEL

Matthew Froid and Vyacheslav Rykov, Department of Mathematics, University of Nebraska at Omaha, NE 68182

Large-scale models of complex, dynamic systems offer a novel approach to understanding how the individual components of such systems interact. In particular, identifying attractors – the state in which the system tends to evolve regardless of starting condition – provides a way of exploring how the individual components influence the rest of the system. While many programs exist that allow for the design of mathematical models, many of these sacrifice a native mathematical toolset for ease of modeling. Here we seek to reduce the reliance upon non-native capabilities for analyzing a large-scale model and identifying its attractors. We use a pre-built deterministic Boolean model of HIV/human macrophage interactions on an open-source platform. The chosen platform Cell Collective is unable to generate a Boolean truth table for any node with $n > 13$ interactions, which is necessary for any many mathematical tests to be performed on the model. Subsequent mathematical analyses on models made using this platform require several non-native programs to translate the logic expressions for each individual node into a Boolean truth table as a binary matrix. To resolve this dilemma, we have developed a single program capable of generating the truth table as a binary adjacency matrix and then directly performing an algorithm for computing the attractors of the model.

DEVELOPMENT OF LOW COST 3D PRINTED ACETABULAR FRACTURE MODELS FOR SURGICAL PLANNING

David Salazar, Justin Cramer, Nathaniel Hunt, Gabe Linke, and Jorge Zuniga, Department of Biomechanics, University of Nebraska at Omaha, NE 68182

Introduction: The use of 3D printed anatomical models is continuing to improve surgical conditions across multiple fields. While many articles encourage the use of anatomical models, few articles discuss the guidelines for their overall production and what methods are acceptable to use for different purposes, such as surgical planning, implant development, and clinical education. The ability to reduce the cost of model production while maintaining anatomical accuracy could improve surgical planning in low-income areas both locally and internationally. The purpose of this study was to compare 3D printed acetabular fracture models produced using different methodologies for potential use in surgical planning. Research design and methods: Five acetabular fracture models were developed

from de-identified CT data using segmentation software and 3D printers at different price points. The measurement error in the printed models representation of the overall anatomy and fracture pattern were analyzed using one-way ANOVAs with a significance value of $\alpha = 0.05$. Survey results of the model's accuracy compared to the CT images and utility as a method of surgical planning were also evaluate with similar parameters. Results: Significant differences were found for the model's representation of the acetabular fracture when comparing the physical measurements to the CT data, as well as when evaluated by the medical professionals ($p = 0.007$ and $p = 0.008$, respectively). Conclusion: It is likely that anatomical models developed at any price point will provide some level of improved anatomy conceptualization. However, the results from this research indicate slight differences likely exist as a result of the method used to develop the model. Further investigation should observe implementation of models developed using the different methods as a part of the surgical plan for an accurate comparison of their utility.

EFFECTS OF ENVIRONMENTAL TEMPERATURE ON EXERCISE RESPONSE AND ADAPTATION

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Space flight is known to result in oxidative damage and mitochondrial dysfunction. This dysfunction has been linked to many common diseases. Environmental temperature conditions during space flight are anticipated to be extreme. Exercise training increases mitochondrial development within skeletal muscle tissue and acclimation to environmental temperature with exercise may provide protective effects for those engaging in space flight. The purpose of this study is to analyze the effects of exercise training within a three week temperature acclimation period on mitochondrial quantity and quality. Thirty-six male subjects performed one hour of cycling five days/week for three weeks in either a hot (33° C), cold (7° C), or neutral (20° C) condition. Biopsies were taken from the vastus lateralis muscle for analysis of mitochondrial quantity and quality on the first and last day of training (pre, post, and 4-hrs post exercise). No significant changes were observed in mitochondrial quantity in any of the temperature conditions. Mitochondrial DNA deletion ratio, an indicator of mitochondrial quality, decreased in the cold compared to hot and neutral conditions. This analysis could provide implications for preparing astronauts better for space flight. It could also assist in alleviating some of the detrimental effects of space flight on mitochondrial function.

DESIGN OF MODULAR ROBOTICS PLATFORM USING THE COMPLIANT ROLLING-ELEMENT JOINT

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We propose to develop a modular, scalable, and customizable platform for robotic joint and link design. The platform is based on the compliant rolling-element (CORE) joint, which acts similar to a system of planetary gears. The goal of this work is to design a CORE joint, of which a prototype will be constructed and tested under various loading scenarios, including in plane and out of plane loading. This will allow us to assess the performance of the joint and optimize the design. Our proposed CORE joint uses a "sandwich" of plates for each side of the joint, as well as a drive link, similar to the carrier in a planetary gear system, all of which can be fabricated through laser cutting, waterjet cutting, or 3D printing. This eliminates other complicated machining processes, and maintains a low entry barrier to building robots. The designs can be easily adapted for varying motor and link configurations, depending on the requirements of each joint. Compliant bands keep the joint surfaces in contact, and provide a tunable joint stiffness, as changing the material or band thickness will affect the joint stiffness.

Optimization of this design will prepare the joint for testing across multiple scales and eventually complete robot prototypes.

DESIGN AND DEVELOPMENT OF A LUNAR REGOLITH TESTBED

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NASA plans to send United States Astronauts back to the moon by the year 2024. For this mission to be successful there are numerous projects that need to be completed. One such project is to send rovers to the moon to prepare landing zones, and protective barriers, for humans. NASA requires force modeling data to design rovers capable of efficient lunar regolith manipulation. This project is the creation of a testbed to measure the forces lunar regolith poses on an end-effector. A scoop is used as the systems end-effector and moves along a programable profile path at various angles of attack through the regolith. Various load cells are used to measure the forces that are experienced by the end-effector along the programmed path. Collected data will then be analyzed, by NASA, to determine the forces required to move a volumetric amount of regolith and how the angle of the scoop may affect these forces. This data will be instrumental in the design process of the new generation of lunar rovers.

EFFECT OF ARCHITECTURE AND PROCESS ON THE ULTRASONIC MAPPING OF HYBRID ADDITIVELY MANUFACTURED MATERIALS

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While additive manufacturing (AM) is ideal for creating high-value components, the synergistic combination of other manufacturing processes or energy sources with AM incorporates the ability to make functionally graded materials. Such materials have a spatial variation in their microstructure and material properties, which provides unique advantages in the overall performance of the material. This expansion of the design and manufacturing parameter spaces presents a challenge for the nondestructive evaluation of AM components although nondestructive mapping of the properties imparted by hybrid AM processes is critical for verification of the desired material organization. In this work, hybrid 316 stainless steel samples are created with varying hybrid architectures and with a variety of hybrid processes. The ultrasonic responses of these samples in terms of the wave speed, attenuation, and diffuse backscatter amplitude, are evaluated for each architecture and process combination. These responses are compared with those from conventionally manufactured samples and traditional AM samples. Additionally, micrographs of the samples are collected for validation. This evaluation provides information on the sensitivity of ultrasonic responses to hybrid architecture and process, highlighting the potential of ultrasonic nondestructive methods for characterization of hybrid AM components. The possible limitations of ultrasonic approaches are also discussed.

EVALUATING THE INHIBITORY EFFECT OF PEAT MOSS ON PYTHIUM ULTIMUM

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Pythium root rot is a disease that can have devastating effects on hydroponically and greenhouse grown plants. Inanimate objects, such as soil or hydroponic substrates, can be sources of inoculum. Previous research evaluated the ability of Pythium to survive on six hydroponic substrates; peat moss, perlite, sand, vermiculite, cocoa fiber, and clay balls. Pythium survived on all but peat moss for nine months, but could not be reisolated from peat moss after three weeks. The objective of the current

research is to determine why Pythium does not survive on peat moss. Peat moss has a low pH, and initial studies focused on the effect of pH on Pythium growth. Some inhibition of Pythium was seen when substrate pH was reduced to pH 4, but the effect was not found with all substrates. Pythium grown in media adjusted to pH 4, 6, 8, or 9 grew best at pH 6, but also grew fairly well at pH 4 and less well at pH 8 or 9. Therefore, pH does not seem to determine the lack of survival on peat moss. Our next step is to see if peat moss produces an inhibitory exudate over time.

ANTHROPOLOGY

TULIPE: A YUMBO CEREMONIAL CENTER

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The Yumbos were a cultural group that lived in what is today known as the Pichincha Province. The Yumbos lived in the north-western portion of the province. They were able to hold their land for thousand years. In that time they built many tolas. Tolas are false hills on top of small hills and mountains. The Yumbos disappear from the archaeological record around the time of the Spanish conquest and there are a few different theories as to why. The main accepted belief is that they were affected by a nearby volcano eruption, and the other main belief is that they were almost wiped out by Spanish diseases, and the survivors joined other groups. Tulipe is a Yumbo ceremonial center located in what was the center of their land hold. Tulipe means water under the tolas. The site is the most famous for the ceremonial pools that are the only known ceremonial pools in the new world. At Tulipe there are seven pools, in various shapes. Each of the pools had coastal sand in the bottom of them when they were excavated. There are even what could be viewed as bleacher at the site for the ceremonies that took place at the site. The Yumbos left behind what are know as tolas or earthed mounds, paths, petroglyphs, and the famous pools left at Tulipe. I want to look into the Ceremonial Center of Tulipe to better understand the pools, tolas, and the artifacts that are housed at the museum. I also want to exam the importance of water to the Yumbos and the conservation of the site.

CHINA'S THREE GORGES DAM: DEVELOPMENT, DISPLACEMENT, AND DEGREDATION

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China’s state-led push towards modernization and enhanced economic growth began in the second half of the 20th century with the advent of the Chinese Revolution (Bo, 2007; Sapiro, 2001; Rozelle et al., 1997). These efforts by the Chinese government were marked by environmentally unsustainable practices that have contributed to high degrees of pollution and environmental degradation that are still being combated today (Feng et al., 2012; Bo, 2007; Sapiro, 2001; Murphey, 1967). The construction of the Three Gorges Dam in Hubei province, China, represents the largest civil engineering project of the modern era. The structure spans the Yangtze River, altering the flow of a river that runs 6,418 km from the Tibetan Plateau to the East China Sea (Morgan & Waretini 2013). Despite the dam’s ability to generate one-sixth of China’s total electric capacity and support over 20% of China’s GDP in 2013, there are signs that China’s attempts to go green may come at a substantial cost to the local population and environment (Morgan & Waretini 2013; Xu et al. 2013; Paerl et al. 2011; Gleick 2009). Some of the environmental and social consequences that have resulted are increased geologic activity, such as earthquakes and landslides; issues involving the resettlement of impacted populations; substantial threats to endangered species and fragile regional ecosystems due to altered river current and sediment flow rates; and the development of dangerous algae blooms (Gleick, 2009; Xu et al. 2013; Jackson and Sleigh 2000; Tan, 2008; Park et al. 2003; Li et al. 2014; Paerl et al. 2011; New and Xie 2008). This paper will argue that the process of developing environmental impact statements should be more transparent and democratic with a stronger focus on sustainability. This would involve a more

thorough investigation of local demographics, environmental thresholds, biodiversity, and ecosystem inter-connectivity.

THE EFFECTS OF TOURISM ON LOCAL POPULATIONS

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This paper discusses the potential effects of tourism on destination's local population. The presentation begins with a brief overview of the literature on tourism and local. Particularly focusing on how non-Western societies are affected when exposed to Western tourists, as related to the commodification of culture and displacement or dispossession of land. The paper also discusses the growing issue of over-tourism and how it effects the destination and the local residents. This paper argues that over-tourism decreases the quality of life of the residents by increasing housing costs, limiting the diversity of economic opportunities, and exposing residents to the misuse of public spaces. The paper concludes by discussing the effects of tourism, such as the political economy, social change, and cultural identity.

THE LINGERING EFFECTS OF BRITISH COLONALISM ON THE KHASMIR REGION

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The negative effects of British colonialism on now independent countries today is unquestionable. Today, India and Pakistan have been in a number of wars, military conflicts, and standoffs. It remains one of the most militarized regions in the world. They fight over the area of Jammu and Kashmir just north of India and west of Pakistan. After the Partition of India in 1947, war broke out between the two countries with Kashmir caught in the crossfire. I look into the negative psychological, economic, and historical effects of how the Partition of India has affected the native people of Kashmir. I examine how the Partition of India in 1947 created the current climate of violence in the regions of Pakistan, Kashmir, and India today. I argue that this partition that split up the former colonies has had detrimental effects on the peoples native to the Kashmir area. Using the postcolonial theory framework to guide this research, I measure the number of independent colonies once controlled by the British in India against the number of casualties from the beginning of the Indo-Pakistani wars to the present. This research aims to fill the gap in research about how colonialism in the Kashmir region has negatively affected the people, while also offering various solutions to the dispute. Future research should examine at other regional wars that have been instigated by British-relinquished independence and how the effects are specific to that region.

FEMALE GENITAL CUTTING AND VOLUNTARY BODY MODIFICATION

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This paper explores the differences in the way traditions and practices are viewed in the Global North versus the Global South by comparing global and local responses with female genital cutting (FGC) with responses to voluntary surgical body modifications. The main reason for differences in the perceptions of traditions in the North vs. South results from the narrative of colonialism and the position of the Global North as a cultural hegemon. FGC is portrayed as a brutal and barbaric tradition perpetuated by rural communities in countries that make up the Global South, while voluntary surgical body modification is seen as a form of choice and empowerment. However, the result is ultimately the same: women are undergoing potentially dangerous procedures as a result of societal pressure. This analysis will compare the differences in the rhetoric and sources between issues in the Global South versus the Global South. Additionally, global responses and framing of the issues will be included in the analysis with the goal of identifying causal mechanisms for these differences. After identifying the

causal mechanism, this paper will discuss the implications of the differences of perceptions of cultural traditions practiced by the Global South and the societal acceptance of customs practiced by the Global North. This presentation argues cultural hegemony and colonialism are the causal mechanisms that perpetrate the differences in the portrayals of practices that take place in the Global North and those in the Global South.

THE GLOBAL ENVIRONMENT COST OF AMERICAN LIFE

Nancy Theodor, University of Nebraska Lincoln, NE 68588

In this presentation, I will explore the global environmental cost that American consumption and improper waste disposal are posing on the environment and especially in developing countries of the world. The climate crisis is an ongoing crisis that will continue to loom before us due to the lack of environmental policy and implementation of proper sustainability and waste practices. The United States is the greatest contributors to the overproduction and emission of potentially polluting materials that are being mass introduced into the environment every day. One way bring light to the major environmental issues cost of American consumption and waste and the ease with which we buy and waste resources. My presentation will answer the question of whether or not the United States' consumer culture is to blame for the disproportional output of environmental pollutants such as plastics, waste, electronics, and emissions. By focusing on this question with credible data and sources, I hope to elicit more sustainability initiatives, while also gauging the audience to consider the underlying factors contributing to the issue and how it affects communities on a broader scale.

THE EFFECTIVENESS OF THE RESPONSIBILITY TO PROTECT DOCTRINE

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The Responsibility to Protect (R2P) doctrine is a significant advancement in mobilizing human rights protections amidst mass atrocity crimes, however, its effectiveness and implementation is still challenged by the international community. The R2P's three pillar approach encourages state responsibility for protecting their populations and calls upon the international community to help fulfill that responsibility, but the first two pillars have evolved into a norm more successively than the third pillar. This study proceeds in two parts: the first analyzes the framework and norm development of the R2P, while the second traces the enactment of the third pillar of the R2P particularly in regard to the Libyan crisis of 2011 and the Syria crisis in 2011-2012. I argue that the first two pillars of the R2P have strong foundations to compel international cooperation against a mass atrocity crime, but the vagueness of the third pillar obscures its intentions and complicates its implementation. As a result, the R2P serves as a justification for plausible action that it does not specify, and it fails to develop into a consistent norm that fully realizes its potential to incite powerful and collective humanitarian action.

APPLIED SCIENCE AND TECHNOLOGY

EFFECT OF LOCAL COLD APPLICATION DURING EXERCISE ON GENE EXPRESSION RELATED TO MITOCHONDRIAL DEVELOPMENT

Ben Meister*, Robert Shute, Christopher Collins, Dustin Slivka, Exercise Physiology Lab, University of Nebraska at Omaha, NE 68182

PURPOSE: Therefore, the purpose of this study is to determine the impact of local muscle cooling during endurance exercise on human skeletal muscle gene expression related to mitochondrial development.

METHODS: Twelve recreationally trained males and females (age 19-45) cycled at 65% Wpeak with one leg cooled (C) with a thermal wrap while the other leg was wrapped but not cooled (RT). Muscle biopsies were taken from each VL before and 4 hours post-exercise for the analysis of gene expression.

RESULTS: Muscle temperature was lower in C (29.2±0.7 °C) than RT (34.1±0.3 °C) after pre-cooling for 30 minutes before exercise ($p < 0.001$) and this difference remained after exercise ($p < 0.001$). PGC-1α and NRF1 mRNA were lower in C ($p = 0.012$) than RT at 4-h post. PGC-1α ($p = 0.001$, $p < 0.001$), NRF2 ($p = 0.042$, $p = 0.020$) and VEGF mRNA ($p = 0.035$, $p = 0.035$) were higher in both legs after cycling. Temperature had no effect on NRF2, TFAM, VEGF or ERRα ($p > 0.05$). Exercise had no effect on NRF1, TFAM or ERRα ($p > 0.05$). There were no differences in mitophagy genes ($p > 0.05$).

CONCLUSION: These data suggest that decreased muscle temperature seems to have an inhibitory effect on PGC-1α and NRF1 expression in human skeletal muscle.

EFFECT OF LOCAL HEAT APPLICATION DURING EXERCISE ON GENE EXPRESSION RELATED TO MITOCHONDRIAL DEVELOPMENT

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BACKGROUND: The stress of exercise training stimulates muscle tissue remodeling and mitochondrial turnover, which includes both mitochondrial growth (biogenesis) and mitochondrial breakdown (mitophagy). Several genes we are going to analyze are associated with transcriptional changes in both mitophagy (PINK 1, PARK2, NIX and BNIP3) and mitochondrial biogenesis (PGC-1α, MEF2, TFAM, ERRα, NRF1, VEGF and NRF2). It has been established that exercise and temperature are two factors that can alter the transcription of genes associated with mitochondrial biogenesis and mitophagy. However, it is currently unknown whether this temperature intervention is due to the environmental temperature's effect on core body temperature or whether it is muscle temperature that effects this.

PURPOSE: To determine the expression of mitochondrial genes by looking at skeletal muscle mRNA following exercise with heat application to the muscle compared to a control.

METHODS: Twelve recreationally trained males (age 19-45) will be recruited for the study. Participants will cycle at 65% Wpeak for an hour with a thermal pad applying heat to one leg while the other is at room temperature. A muscle biopsy will be taken from the vastus lateralis before exercise as well as immediately after and 4-h post-exercise for gene expression analysis.

STEPPING FORWARD: QUANTIFYING THE ORTHOGONAL RELATIONSHIP BETWEEN GAIT AND BALANCE CONTROL IN OSCILLATING

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Previous gait research has shown that the ratio of anteroposterior (AP) and mediolateral (ML) step width variability reversed when the direction of progression changed from forward to sideways walking. Additional research has shown visual perturbations induce substantial lateral variability but only considered the effects of sudden perturbations during otherwise normal walking. However, it is not clear from these studies if the orthogonal shift in variability was an effect of change in the orientation or an effect of visual feedback from a natural environment with optic flow. In addition, it is also not clear

if the orthogonal shift in variability was gradual or discreet as the difference between the direction of progression and that of optic flow increases. Our goal is to advance current literature by quantifying the orthogonal relationship between gait and balance control as well as determine the contribution of vision and proprioception to this relationship. Quantifying the relationship of balance and gait control over a range of sensory feedback signals may provide novel insights, which can be used to improve current neurorehabilitation training paradigms. The continuous steady state characteristics of normal walking, walking on a moving platform, and walking in an environment with conflicting sensory information has been collected from 19 healthy young adults. Initial results indicate that balance control is sensitive to conflicting visual information. Our results support recent findings that show non-dominant-leg foot placement is more variable than dominant-leg foot placement.

BEE MYCHOTELS: A NOVEL MYCELIAL BUILDING MATERIAL USED TO AUGMENT SOLITARY BEE AND WASP POPULATION CONSERVATION

Katy Ayers*, Samantha Martinez, Cynthia Sanchez, Lisset Oropesa, Elizabeth Ewing, Shayla Douthit, Michael Bates, Landon Sokol, Donovan Egger, Steve Heinisch, Lauren Gillespie, Department of Science Education, Central Community College, Columbus Nebraska 68602

Rapidly declining bee populations have become increasingly common. Concerns are focused on honey bees while North America's other native pollinators are in peril. Solitary bees are often overlooked despite pollinating 80% of flowering plants. Previous research shows mushrooms are beneficial to bee's immune systems. When bees drink exudates (or juices) produced by the mushroom Ganoderma sp., they are better able to fight two viruses responsible for bee declines. We plan to grow fungal-mycelial bee hotels (MycHotels) to increase solitary bee exposure to exudates. The MycHotel project is focused on bee conservation and promotes development of diverse ecological communities. If solitary bees and wasps are attracted MycHotels, this could be critical for farmers; they could place large MycHotels near crops instead of renting bees for pollination. Mycelium will turn organic matter to soil, and old hotels can be used as compost naturally boosting soil health. MycHotels will be grown through a novel process that utilizes mycelium itself as a renewable, living building material. Boxes will be grown and deployed spring 2020 and collected for analyses of larvae when pollination seasons end. The material is waterproof, has been used to build a canoe, and, we found no pores under a scanning electron microscope at ~150,000X. We will present our prototype, observational changes in behavior/use of deployed boxes, and further analyses of the novel building material using scanning electron microscopy and other techniques. This mycelial building material offers new applications in how bio-materials can successfully augment new or ongoing conservation efforts.

STUDY OF THE COMPOSITION OF VARIOUS WOOD EXTRACTS.

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The extracts of wood contain substances such as waxes, fats, resins, and a variety of flavor compounds (several 100). Most of the extractable components are known. Here we compare the volatile organic compounds such as lactones, phenols, vanillins, and esters that are extracted from various types of wood. The comparisons include:

1. if the extraction technique (reflux or sonication) impacts composition;
2. if the type of solvent, such as water, ethanol, hexanes, etc., impacts the composition of the extract;
3. the composition of the extracted compound between types of wood, such as oak and cherry.

The comparisons and identifications were completed using GC/MS. Lastly, color comparison of the extracts were done visually and using UV/Vis.

ENHANCED POOL BOILNG OF FC-72 ON FEMTOSECOND LASER SURFACE PROCESSED 6061 ALUMINUM SURFACES

Justin Costa-Greger*, Alfred Tsubaki, Collin Hoffman, Dylan Sorrell, Antony Hamilton, Craig Zuhlke, Dennis Alexander, Jeff Shield and George Gogos, Department of Mechanical & Materials Engineering, University of Nebraska-Lincoln, NE 68588-0526

We will present methods for studying pool boiling on femtosecond laser processed 6061 aluminum (Al 6061) using FC-72 as a working fluid. Femtosecond laser surface processing (FLSP) has been shown to be a passive, permanent, and scalable modification process that has potential for industrial use. FLSP creates quasiperiodic, mound-like micro and nano-scale features on the surface that increase the area available for boiling, promote capillary wicking, and increase the number of potential nucleation sites. While literature typically focuses on pool boiling using water due to its well understood properties, utilizing aluminum as a boiling surface in water has the additional challenge of repeatability due to the formation of a boehmite layer as the aluminum reacts with hot water. The boehmite layer, AlO(OH), forms nanoscale protrusions that increase the wettability and enhance the critical heat flux. Special care must be taken in order to develop a stable boehmite layer that will result in repeatable data. This special consideration, as well as industrial interest in dielectric fluids, led us to examine the effects of FLSP on aluminum surfaces using FC-72, which does not react with aluminum. Results will be presented on the enhanced heat transfer performance by using FLSP on Al 6061 surfaces. Laser parameters such as fluence and pulse count were varied to determine how each parameter influences the heat transfer performance.

DECOMPOSITION OF ETHANOL IN RED WINE BY POTASSIUM DICHROMATE IN SULFURIC ACID

Jasmine DeMonte* and Darius Agoumba, Department of Physical Sciences and Mathematics, Wayne State College, Wayne, NE 68787

Procedures describing oxidation of alcohols are readily available in the scientific literature. One of the oxidants used in the kinetics of alcohol oxidation is potassium dichromate. It reacts with ethanol to produce aldehyde and carboxylic acid when the amount of alcohol is larger than that of the oxidant. It is our understanding that potassium dichromate will decompose ethanol in wine. The investigations have allowed the determination of half-life and the percent alcohol in wine by volume using spectrophotometry and a calibration curve from known ethanol-water mixtures. Results can be used to assess wine quality.

THE SPECS ON SMART-NEST-BOX TECHNOLOGY: COMMUNITY COLLEGES AND INTERDISCIPLINARY RESEARCH

Donovan Egger, Dylan Smith, Michael Bates, Landon Sokol, Tychique Kutalu, Hanva Bassembat, Aiden Cromwell, Steve Heinisch, Lauren Gillespie*, Department of Academic Education, Central Community College, Columbus, Nebraska 68601

Program areas in mechatronics and computer science at both two- and four-year colleges are becoming more important as coding functionality becomes an essential skill across disciplines. We are a community college student-cohort studying science, technology, engineering and mathematics (STEM) funded by a National Science Foundation S-STEM scholarship program. We are breaking down barriers in the academic system and have been working on a project bridging gaps across academies and disciplines while providing accessible technology to cavity-nesting researchers or enthusiasts.

Here we present a product iteration that will allow us to obtain video, photos, or specific song-recordings usually requiring costly equipment, and to reduce nest disturbance while monitoring non-breeding and breeding presence in bird boxes. Boxes will access wireless technology through the use of the loRa chip, a long-range communication device in concert with a statewide wireless infrastructure created by company Paige Wireless. We will use a specific central processing unit (CPU), the ESP32, a low-cost system-on-chip (SoC) series created by Espressif Systems©. It is powerful and cheap with a dual core so it can handle multiple processing loads at one time. The low cost and sleek design make them ideal for prototyping. This model is weather proof and enables us to have sturdy mobile communication anywhere, especially as the ESP32 can interface with other systems for wireless internet access. We are in the process of developing the casing for box electronics using 3-D printing technology. This project brings together biology, medical sciences, engineering, electronics, mechatronics, and robotics, the future makeup of an interdisciplinary STEM dream team.

A MACHINE LEARNING (SVM) APPROACH FOR FAILURE PREDICTION IN SDN OVER WDM NETWORKS

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Network reachability is an important factor of an optical telecommunication network. In a wavelength-division-muliplexing (WDM) optical network, any failure can cause large amount of loss and disruptions in network. Failures can occur in network elements, link, and component inside a node or etc. Since major network disruptions can caused network performance degradations, it is necessary that operators have solutions to prevent such those failures. This work investigates a protection approach using a Machine Learning (ML) algorithm called Support Vector Machine (SVM). ML is a hot topic which emerged recently specially in optical networks. Our approach consists predict any potential equipment failure in a WDM network using support vector machine (SVM). The simulation result shows the advantages of using SVM method. Also, it has proved that the prediction accuracy was greater than 90%. It means the failure state of 95\% of the boards could be correctly predicted. Also, we aggregated multiple simulations to guarantee a 95\% confidence. Our simulation results demonstrate that our method can predict an equipment failure risk with high accuracy. The SVM method for predicting failure can effectively improve traditional models to protect services from possible failures. Since prediction model can prevent damage from any failures in optical backbone networks therefore, it can significantly enhance the optical network stability.

CONSENSUS IN COOPERATIVE MULTI-AGENT SYSTEMS AND SIMULATION IN ROS ENVIRONMENT

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Consensus in a dynamic multi-agent system is aimed at guaranteeing that the agents converge to approximately the same global view of their information state. In such a system, the network topology is dynamic in the sense that the agents are mobile and the update to the network information state is based on cooperative control of the agents through their local view of the network. Following a particular algorithm, each agent repeatedly updates its information state by exchanging information with its immediate neighbors until the consistent view is reached. In such systems, the network topology is normally partially connected and thus the communication among agents is partial. The agents can be robots, computers and vehicles, among others. Applications where such cooperation can be used include the rendezvous problem in which the agents are expected to meet at the same time or reach the same destination, the behavioral consensus among agents to stay at fixed desired distance from each

other, object localization to identify the location of the object, and evaluating the centroid of a particular geometric formation. This study is focused on the design of an algorithm for computing the needed consensus equations through partial communication among multiple robots in order to reach a particular destination. Verification is done through simulation in Robot Operating System (ROS).

In this study, information exchange among robots is modeled as a dynamic directed graph and the nodes in the graph are the robots. To compute a consensus destination for robots, a system of first order differential equations is generated. For a small number of robots, a closed form solution for computing consensus destination can be obtained using eigenvalues and eigenvectors. Through ongoing exploration, we have derived a numerical method to compute consensus from some initial graph topologies, i.e., from some given robots' positions and given their communication links. The work has been verified using ROS. That is, the implementation of the numerical method in ROS was able to successfully move the robots to the correct computed consensus destination.

ESTABLISHING CONTROLLED DECOHERENCE IN QUANTUM COMPUTERS TO INVESTIGATE THE TRANSITION FROM QUANTUM TO CLASSICAL

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Why do we observe a classical world that is fundamentally described by quantum mechanics? This question, referred to as the Quantum Measurement Problem, has remained unanswered since the birth of Quantum Mechanics nearly a century ago. A new theory, called Quantum Darwinism, claims to solve this problem. A key component of this new theory is decoherence, a process that quantum systems undergo when they interact with their environment. Experimental tests of this new theory will require the ability to control and distinguish between decoherence and the closely related process of dephasing. The goal of this project is to determine whether we can obtain this control on the publicly available IBM Quantum Computer. We will use two recently proposed data analysis techniques to verify our ability to implement, control, and distinguish between decoherence and dephasing. The success of this project is expected to lead to further studies of Quantum Darwinism and the decoherence process.

BIOLOGICAL AND MEDICAL SCIENCES

PROTEIN RELATED TO ALZHEIMER'S DISEASE PLAYS A ROLE IN ZIKA VIRUS INFECTION

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Zika virus (ZIKV) is a neurotropic flavivirus, infection by which can lead to microcephaly in babies and Guillain-Barre syndrome in adults. Flaviviruses are single-stranded RNA viruses, including West Nile virus and Dengue virus. Amyloid Precursor Protein (APP) is a membrane protein associated with the development of Alzheimer’s disease through its involvement in the generation of amyloid plaques. APP is predominantly expressed in the brain and has restricted expression in other organs, so the roles it may play outside the brain are not fully understood. Although there is plenty of research on ZIKV, there is no clinically approved treatment or vaccine for ZIKV-mediated diseases. There is limited knowledge regarding what host factors ZIKV interacts with to modulate the progression of the disease. The spleen is the organ of the body dedicated to filtering the blood, removing old and damaged blood cells. As part of the lymphatic system, it plays a crucial role in mounting an immune response to bacterial or viral infections. In the spleen, the level of APP expression is usually low. We have demonstrated that ZIKV infection in mice causes the upregulation of APP protein in the spleen.

Additionally, we observed that cells expressing APP have more protection against ZIKV and provide protection for other surrounding cells. The overexpression of APP in the spleen may play an important role for the host to counteract ZIKV-mediated pathogenesis. We are currently working to ascertain the exact role of APP, its induction mechanism, and how this expression influences ZIKV replication using a genetic approach. This work may provide novel information about host-viral interaction and a potential target for anti-ZIKV treatment. It also could provide information about ZIKV and the development of Alzheimer's, with both being linked to APP expression.

EFFECT OF DISC1 AND DYSBINDIN KNOCKOUT IN NEURONAL DIFFERENTIATION

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Schizophrenia is governed by the susceptibility factors involved with neuronal development, in relation to the proteins dysbindin and DISC1. DISC1 stabilizes dysbindin by forming a complex between the two proteins that results in decreased ubiquitination of dysbindin. Therefore, DISC1 and dysbindin participate in the regulation of cell proliferation, differentiation, neuronal outgrowth and cell-to-cell adhesion. Using the genetic editing technology, DISC1 and dysbindin will be knocked out in pheochromocytoma Rattus norvegicus (PC12) cells. The PC12 cells will be induced to differentiate to produce mature neurons. The effects of the loss of DISC1 and dysbindin on neuron differentiation and dendritic spine formation will be assessed using the neurite outgrowth assay.

THE IMPACT OF HEARING LOSS ON THE NEURAL OSCILLATORY DYNAMICS OF VISUAL SELECTIVE ATTENTION IN CHILDREN

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Visual selective attention is the process by which irrelevant stimuli are selectively inhibited so that behaviorally relevant stimuli can be processed. Previous behavioral work in adults and children with profound hearing loss has shown that these individuals may have aberrant selective attention abilities relative to their normal-hearing counterparts. Nonetheless, whether these decrements extend to those with intact, albeit degraded hearing loss (i.e., those with mild-to-severe hearing loss) remains unclear. Further, the neurophysiological mechanisms by which these processes occur has not been probed in children. The goal of this study was to identify the impact of hearing loss on the neural mechanisms that underlie selective attention processing in children. In this study, 43 children aged 7-15 years, including 23 children with mild-to-severe hearing loss (CHL) and 20 children with normal hearing (CNH) performed an arrow-based version of the Erikson flanker task during magnetoencephalography (MEG). Briefly, during the flanker task, participants are asked to respond whether a centrally-presented arrow is pointed to the left or the right. In half of trials, there are "flanking" arrows that are pointed in the same direction as the central arrow (congruent condition), and in the other half of trials, "flanking" arrows are pointed in the opposite direction (incongruent condition). Trial condition was pseudo-randomized. Classically, participants are slower to respond to incongruent stimuli relative to congruent stimuli; this is termed the flanker effect. MEG data was subject to artifact correction, epoched, and transformed into the time-frequency domain. Significant oscillatory responses were imaged using beamforming, and the impact of congruency (i.e., congruent vs. incongruent) and group (i.e., CNH vs. CHL) were assessed. Differing alpha-frequency based flanker effect was discovered in the frontal and parieto-occipital gyrus. This provides preliminary evidence that there is altered neurocognitive functions between CHL and their CNH peers.

DEVELOPING AN INSOLE PRESSURE SENSOR FOR REHABILITATION APPLICATIONS

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Real time plantar pressure information has a wide range of applications in both research and rehabilitation. One key application of this technology is to assist patients recovering from joint replacement surges understand and prevent the overloading of recovering tissue. The use of biofeedback devices has previously been show to improve patient compliance with weight-bearing instructions. In this study, a smart insole was designed and developed to measure real time foot plantar pressure inside the subject's shoe. Key features of the insole is cost-effectiveness, durability, good working pressure detection range, and wireless data transfer to a mobile device.

NON-INVASIVE OPTICAL QUANTIFICATION OF STRUCTURAL AND FUNCTIONAL CHANGES OF COLLAGEN IN CHRONIC-UVA-EXPOSED SKIN

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Collagen is the main structural protein in the extracellular matrix and is the main component of connective tissue. Collagen's specific function is to provide strength and elasticity to the skin, tendons, ligaments, and other tissues in the body. When exposed to UVA radiation, the healthy fibrous collagen is broken down and reformed in an irregular pattern by fibroblasts trying to repair the tissue. A different form of collagen remodeling also occurs with the development of cancer. Collagen, when excited by single-photon UV light or multi-photon near-infrared light, emits fluorescence and can be imaged by laser scanning microscopy. Similarly, collagen can also be imaged using second harmonic generation of intense pulses of near-infrared light. We designed a custom in vivo microscope and conducted a longitudinal study of chronically UVA-exposed SKH1 mice to determine whether these techniques will be useful as an approach for non-invasive optical biopsy. Results and future approaches to the quantitative analysis of collagen structure in vivo will be discussed.

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EVALUATING SUBSTITUENT EFFECTS OF ETHER-CONTAINING 1,3,4-TRISUBSTITUTED-1,2,3-TRIAZOLIUM SALTS

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1,3,4-Trisubstituted-1,2,3-triazolium salts are quaternary ammonium compounds (QACs) that have antimicrobial properties against bacteria and fungi, with their potency being substituent dependent. The purpose of this study was to analyze the antimicrobial and rearrangement properties of compounds containing aryl ether analogs at the C4 position. A library of salts was prepared with the N1 and N3 positions substituted with 4-tert-butylbenzyl and benzyl groups. All triazolium salt compounds were prepared using copper-catalyzed azide-alkyne cycloaddition, followed by benzylic substitution. At equimolar concentrations of triazole and benzyl bromide reactants, rearrangement of substituents at the N1 and N3 position was observed when the C4 position was substituted with both alkyl and ether analogs. In order to determine the influence of steric properties on rearrangement progression, the C4 position was substituted with phenoxymethyl, 3-phenylphenoxymethyl, and 2,6-dimethylphenoxymethyl

groups and analyzed by mass spectrometry. The influence of electronic properties on rearrangement progression was also analyzed by mass spectrometry using fluoro-, chloro-, and methoxy-substituted phenyl analogs. The antimicrobial properties of triazolium salts with matching N1 and N3 substituents were evaluated using microdilution minimum inhibitory concentration (MIC) assays. MIC values as low as 2 micromolar for Gram-positive bacteria, 16 micromolar for Gram-negative, and 2 micromolar for fungi were observed. Details regarding the synthesis, characterization, and antimicrobial assays of relevant compounds will be presented. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

ACTIVATED CHARCOAL INTERACTIONS WITH PLAQUE FORMING BACTERIA

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Streptococci species is a bacteria found in the formations of plaque on the tooth enamel. Plaque can lead to further complications within the oral cavity. Streptococcus mutans (S. mutans) is a leading bacteria of tooth decay and pathogenesis. The acceptance and production of organic molecules within the oral cavity provides bacterial communication to form a plaque film. Many toothpastes are available to maintain oral health, but the main focus will be activated charcoal toothpaste. Activated charcoal is produced from high pressure and heat then the powdery substance is carbonized. The carbonization causes a porous surface area that gives organic molecules a binding spot on the surface of the charcoal molecule. Activated charcoal toothpaste has not been observed for interaction with the organic molecules of plaque forming bacteria. Charcoal has been observed to bind to organic molecules in other medical usages. The hypothesis for the research is that activated charcoal will reduce the growth of Streptococcus mutans. The bacteria were grown on six plates and analyzed for regrowth after simulating brushing. The brushing consists of a two-minute swirling motion to simulate brushing habits. One plate was used as a control and did not have toothpaste placed on the bacteria. The second plate was brushed with a regular paste. The last four plates were brushed with paste with different concentrations of activated charcoal and kaolin clay. Kaolin clay was used as a second abrasive to compare to activated charcoal. Activated charcoal does act as an abrasive to remove the bacteria off the plates but the activated charcoal also spreads the bacteria over a larger surface. The results have not been quantified at this point and data analysis continues.

CRISPR SCREEN OF ACTIVELY AND LATENTLY INFECTED HIV CELL LINES

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Space travel has been linked to the activation of dormant viruses, which could present a significant health risk to immunocompromised astronauts. Human Immunodeficiency Virus (HIV) may help shed some light on the subject; HIV, while treatable, remains incurable due to the presence of latently infected cells in patients. In this research project, we explored targeting cellular proteins to block HIV expression or inhibit the reactivation of latent HIV. HIV latency was modeled in Jurkat T-cells using a dual colored marker virus that allowed for identification of latent versus active replication. We first hit actively infected cells with the CRISPR library to attempt to knock out HIV expression via cellular targets. Second, we hit HIV latent cells with the CRISPR library to try to permanently silence HIV expression. This was tested by exposure of the cells to latency reactivating agents (LRAs) to see if targeting cellular proteins could prevent reactivation of the latent virus. The main objectives were to find the cellular targets that CRISPR modified in order to (1) silence/deactivate HIV infected cells and/or (2) prevent latent cells from reactivating. The former would have been beneficial to patients currently

infected with active HIV, while the latter had promising applications including potential preventative treatment of HIV. However, upon analysis of the flow cytometry results, we concluded that the CRISPR treatment did not significantly induce deactivation of HIV in infected cells nor prevent activation of HIV latent cells.

1,2,3-TRIAZOLE-CONTAINING PHENANTHRIDINES: SYNTHESIS AND ANTIMICROBIAL EVALUATION

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1,3,4-Trisubstituted-1,2,3-triazolium salts have been shown to possess antibacterial and antifungal properties, though these properties vary depending on the substituents utilized. This project's aim was to investigate whether ring-fused analogs of 1,2,3-triazolium salts representing the 1,2,3-triazole-containing phenanthridine ring system also display such biological activity. This included a comparison of fused and non-fused analogs as well a brief survey of substituent effects. 1,5-Disubstituted-1,2,3-triazoles were prepared from a base-catalyzed click reaction between terminal alkyne and aryl azide reactants. The ring-fused 1,2,3-triazole-containing phenanthridine analogs were prepared by an intramolecular Pd-catalyzed cross-coupling "fusion" reaction of 2-bromoaryl-substituted triazole precursors. Triazolium salts were prepared by N3 benzylation of each analog, resulting in a total of 16 different compounds in this study. Analysis of antimicrobial properties was conducted via minimum inhibitory concentration (MIC) assays. This analysis included both Gram-positive and Gram-negative bacteria as well as yeast in order to complete a thorough investigation of the antibacterial potential. Within this series of 16 triazolium salts, the MIC activity indicated a maximum potency of 0.4 micromolar for Gram-positive bacteria, 16 micromolar for Gram-negative bacteria, and 31 micromolar for yeast. Fused-ring phenanthridine analogs generally showed increased MIC potency relative to their non-fused triazolium salt counterparts. When comparing substituent effects, 4-tert-butylbenzyl substituents at the N3 position displayed the highest potency, as did the incorporation of chlorine groups on the arene subunits. Details regarding the synthesis, characterization, and antimicrobial assays of these compounds will be presented. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

UTILIZING CHEMICAL MUTAGENESIS TO DETERMINE U21 MECHANISM OF ACTION IN TOXOPLASMA GONDII

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The intracellular parasite, Toxoplasma gondii (T. gondii) is the causative agent of toxoplasmosis and infects up to one third of the world's population with some regions experiencing much higher infection rates. Although asymptomatic in patients with intact immune systems, those with weakened ones (such as cancer and AIDs patients) can experience a multitude of ocular, pulmonary, and central nervous system diseases. Pregnant hosts can also transmit the parasite to the unborn fetus. Drug treatments for T. gondii are currently limited, with the standard being pyrimethamine, a dihydrofolate reductase inhibitor. Dihydrofolate reductase is an important enzyme in nucleotide synthesis but due to the similarity between the parasite's enzyme to that of the human, pyrimethamine exhibits toxic side effects such as nausea, repeated vomiting, and nervous system damage at high doses. Our lab investigates an experimental compound, U21, which has shown a 100% survival rate in mouse models. We are now investigating its mode of action. Many drugs function by binding to specific protein targets

and rendering them useless. Since the DNA is directly responsible for the synthesis of proteins, we can modify the DNA to ultimately change the protein being produced. If the modified protein is the target of the drug, the mutated parasite will survive high doses of drug treatment, therefore inducing drug resistance. This process, chemical mutagenesis, has been utilized in our lab to introduce resistance in parasites hopefully containing a mutation in U21's drug binding site. The most resistant populations we have observed are 1.76x, 1.67x, and 1.58x compared to the wild type IC50. Whole genome sequencing will be done to identify single mutations shared between the resistant clones and compare them to the wild type parasite.

HETERODIMERIZATION OF SATB1 AND SATB2 PRIOR TO NUCLEAR TRANSPORT

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Satb1 and Satb2 are closely related proteins that regulate gene expression through chromatin reorganization. The relative concentrations of Satb1 and Satb2 have been implicated in the regulation of embryonic stem cell differentiation through regulating the expression of Nanog. Satb1 is thought to form homodimers or homo-oligomers through interactions with its N-terminal domain. The high degree of conservation between Satb1 and Satb2 has led to speculation that they can form heterodimers. We hypothesize that Satb1 and Satb2 dimerize in the cytoplasm prior to their entry into the nucleus. However, the degree of similarity between Satb1 and Satb2 make it challenging to employ traditional biochemical approaches such as co-immunoprecipitation. Here, we propose a set of experiments using fluorescence microscopy to determine if there is interaction between Satb1 and Satb2, and whether this interaction is dependent on the presence of DNA. Pairs of chimeric proteins will be co-expressed in HeLa cells. Each protein will feature a different fluorescent protein, and one of these in each pair will have its Nuclear Localization Sequence (NLS) mutated to a loss of function. This NLS-deficient mutant will only be able to be imported into the nucleus through dimerization with its import-competent partner prior to its import.

AVIAN HUMORAL RESPONSES TO BUGGY CREEK VIRUS AND ITS ARTHROPOD VECTOR, THE SWALLOW BUG.

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Alphaviruses, of the family Togaviridae, are singled stranded RNA arboviruses. Buggy Creek (BCRV) is like other alphaviruses in the fact that it has avian hosts but differs in the fact that their arthropod vector is the swallow bug rather than the mosquito. High levels of viral replication and overproduction of cytokines are characteristic of an alphavirus-induced disease that often affects young animals. BCRV has been shown in some avian hosts to affect nestling birds more than adult birds. These young animals have an underdeveloped innate and adaptive immune system, which can lead to insufficient immune responses and increased susceptibility to BCRV. In this study, the humoral immune responses of avian species to BCRV and the swallow bug, the arthropod vector, were analyzed by looking at the levels of BCRV and swallow bug specific antibodies in plasma. We use these results to better understand how avian species develop a humoral immune response to alphaviruses and their arthropod vectors.

SEASONAL POPULATION DYNAMICS OF SWALLOW BUGS (OECIACUS VICARIUS) AND THEIR ENDEMIC ALPHAVIRUS, BUGGY CREEK VIRUS

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Alphaviruses are arthropod-borne viruses known to cause millions of cases human disease each year. Further, morbidity and mortality rates linked to alphaviruses are on the rise, likely due to increased contact with arthropod vectors. Among alphaviruses, Buggy Creek virus (BCRV) is unique as it is transmitted by a cimicid insect (the swallow bug) closely related to the human bed bug (Cimex lectularius & Cimex hemipterus). While human bed bugs are not known to transmit human disease, they are considered potentially competent vectors, making further study of alphavirus-cimicid vector systems pertinent to prevent possible future epidemics. Swallow bugs, which are hematophagous ectoparasites that feed on cliff swallows (Petrochelidon pyrrhonota), exist within cliff swallow nests year-round while cliff swallows are only present during late spring and early summer to breed and rear nestlings. Previous research has indicated that Buggy Creek virus undergoes seasonal changes in virulence in swallow bugs, with virally-induced cytopathic effect being highest in the summer, but low the rest of the year. However, specific details of these seasonal changes have not been elucidated. We compared the cytopathic effect (as determined by a TCID50 assay in Vero cells) of swallow bug homogenates (collected monthly) with the induction of apoptosis (caspase pathway induction) in Vero cells, and determined that while cytopathic effect is variable in both detection and appearance, apoptosis induction is a more sensitive measurement for alphavirus phenotype determination in these insect vectors. Both types of assay show detectable and differentiable results among bug ages and months, especially May through August. Further, qRT-PCR multiplexing shows population-wide genetic changes. These results allow us to more accurately determine viral phenotype in swallow bugs throughout the year and have the potential to improve our ability to predict the timing and seasonality risk of arboviruses in other disease systems.

VIRAL ANTIBODIES IN PLASMA, DNA DAMAGE, AND HEAVY METAL CONTENT, OF FEATHERS IN A POPULATION OF BARN SWALLOWS WITH PARTIAL ALBINISM

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A population of North American barn swallows (Hirundo rustica erythrogaster) is under study in Columbus, Nebraska for partial albinism identified in individuals captured during a routine general biology lab for Central Community College. We noticed white patches on forehead and throat areas, inconsistent with typical melanic coloration in this species, in addition to discrepancies in lengths of tail streamers. Facial plumage and tail streamer abnormalities are consistent with documented plumage development issues in other species due to the Buggy Creek Virus, and they are also consistent with genetic-based partial albinism in barn swallow populations exposed to radiation in Chernobyl, Ukraine.

Swallows were captured and sampled in 2019 in Columbus, NE. Blood and plumage samples were taken and facial plumage variation was photographed and will be quantified using ImageJ software. Plasma samples will be analyzed for viral antibodies to the Buggy Creek Virus. DNA samples will be analyzed using a comet assay to test for DNA damage. Samples are currently under analysis using X-Ray fluorescence to identify heavy metals, as birds will often sequester heavy metals in feathers. We found that all samples have high percentages of sulfur and chlorine and moderate percentages of calcium, phosphorus, and aluminum. Other elements appearing in lower percentages, but not all in

samples, are magnesium, iron, sodium, silicon, and potassium. Chromium, a heavy metal known to cause health problems in humans, and strontium, a highly reactive and rarely occurring metal have also been found, and, we still have over 35 samples to analyze. Preliminary morphological results show that hatch-year barn swallows are in worse body condition and have higher fluctuating asymmetry in tail feathers than do adults.

5'UTR STRUCTURE ANALYSIS OF ENTEROVIRUS D68 VIA SHAPE-MAP

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Enterovirus D68 is a single-stranded positive-sense RNA virus that belongs to picornaviridae family. First isolated in 1962 in California, EV-D68 only had minor cases of respiratory illness associated with it until 2014. Since the summer of 2014, reported outbreaks for EV D68 has been increasing with a strong association with polio-like acute flaccid myelitis (AFM). EV D68 utilizes its 5' untranslated region (5'UTR) to recruit the ribosome to undergo cap-independent translation. Ample evidence suggests that the 5'UTR which includes the internal ribosome entry site (IRES) plays an important role in determining the virulence of the virus. Understanding the structural changes in 5'UTR of current EV D68 strains from the ones in 1962 can help determine the reason for its newly gained neurotropism. A robust secondary structure of the 5'UTR will be generated using the SHAPE- MaP analysis. This method involves chemical modification of the 2' hydroxyl group of nucleotides in the RNA molecules based on their position and flexibility. The modified molecule is converted into cDNA and sequenced to create mutational profiles. By analyzing the sequence and using computational tools, the 5'UTR structure can be generated. Elucidating a novel 5'UTR of EV D68 will not only reveal the structural changes leading to neurotropism but comparative studies with other structures will also help find virulence determining key structural features shared among enteroviruses.

EXPRESSION OF VIR-1 AND VAGO IN NORA VIRUS INFECTED DROSOPHILA MELANOGASTER HEMOLYMPH

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D. melanogaster is a valuable model to study the immune system. Analysis of the D. melanogaster immune response to viral infection can be used to inform future immune research and applications to human innate immunity. Two D. melanogaster proteins, Vago and Virus-induced RNA 1 (Vir-1), are candidates for analysis due to upregulation in response to viral infection but are uncharacterized in response to Nora virus. Nora virus is a persistent, picorna-like virus, which replicates in the gut of D. melanogaster. While the complete pathology of Nora virus is unknown, we have identified a locomotor defect and decreased longevity. We hypothesize that Nora virus is circulating in the hemolymph of Nora virus-infected D. melanogaster, allowing for migration beyond the gut. Western blot and qRT-PCR analysis has demonstrated the presence of Nora virus capsid proteins and RNA in the hemolymph of Nora virus-infected D. melanogaster, suggesting these viral components may circulate to other tissues and cause novel effects including the observed locomotor defect. Analysis by qRT-PCR has demonstrated biphasic viral load and closely associated vago transcription levels, which suggests an antiviral function of vago. Additionally, Western blot analysis has demonstrated vir-1 expression in uninfected D. melanogaster suggesting an alternative function. The project described was supported by grants from the National Center for Research Resources (5P20RR016469) and the National Institute for General Medical Science (8P20GM103427), a component of the National Institutes of Health.

INVESTIGATION OF CURCUMIN AND ITS ANALOGS AS ADENOSINE RECEPTOR AGONISTS FOR TREATING CHRONIC PAIN

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Chronic pain debilitates millions of people throughout the world. From the mid-1990s until the present, the principle pharmacologic treatment for chronic pain has been long-term administration of opioid medications. However, between 1999 and 2007, the number of deaths related to opioid drug overdose rose throughout the world and more than tripled in the USA, causing concern. In response, studies have been initiated to discover new analgesics that carry a lower risk of addiction and overdose-related death. All four adenosine receptor (AR) subtypes (A1 AR, A2A AR, A2B AR, A3 AR) have been investigated as targets for analgesic drugs, but concerns about cardiovascular side effects are impeding translation to the clinic. Drugs that are selective for A3 AR offer a solution, because they inhibit pain without cardiovascular effects. Our aim is to clarify the structural characteristics of molecules that make them more selective for A3 AR over other ARs. To generate ARs for testing, three human embryonic kidney cell lines are being grown, expressing A2A, A2B, and A3 ARs respectively. We have selected curcumin as our test molecule because it has documented analgesic properties and because its binding affinity for ARs has not previously been described. We use photochemistry to alter curcumin, changing it from trans-trans to cis-trans. Both forms of curcumin are then evaluated for their binding affinity (Ki) for each of the AR subtypes using fluorescent ligand competitive binding assays. Results thus far show that isomerized curcumin binds to ARs more strongly than unmodified curcumin. Further binding assays will reveal whether isomerized curcumin is selective for A3 AR over other ARs. Further testing with cAMP ELISAs will reveal whether binding of isomerized curcumin is associated with receptor activation. Activation of A3 AR will result in depressed cAMP levels because A3 AR is coupled to Gαi. Activation of A2AAR and A2B AR will result in elevated cAMP levels, because both A2 ARs are coupled to Gαs. In summary, the structure activity relationships discovered by this study will help future pharmacologists to design molecules that target A3 ARs for the alleviation of chronic pain.

ROLE OF DYSBINDIN, WAVE-2, AND API-1 IN THE STABILIZATION AND ORGANIZATION OF ACTIN IN NEURAL CELLS

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The dystrobrevin-binding protein-1 gene (DTNBP-1) has been found to be highly active during periods of neurogenesis with production of the neuro-dependent protein dysbindin. Allelic variations to dysbindin result in shortened neurite outgrowth and disorganization of the neuronal actin cytoskeleton. The intermediate molecular components between dysbindin and actin are unknown as dysbindin is highly interactive with many binding partners. Previous molecular work has shown an interplay between dysbindin, Wave-2, and Api-1. Wave-2 and Api-1 have been found to form a complex within various cells for reorganization and stabilization of the actin cytoskeleton. Behavioral effects due to dysbindin knock-out were investigated using Drosophila melanogaster in climbing and working memory assays. Climbing assays showed no difference for the innate behavior of negative geotaxis between dysbindin knock-out and wild type D. melanogaster. Working memory was evaluated using a shocking associated scent T-maze, with decrease working memory found in dysbindin knock-out. The role of dysbindin, Wave-2, and Api-1 in organization and stability of actin cytoskeleton during neurogenesis was investigated using immunofluorescence and neuronal differentiated PC-12 cells. Immunofluorescence was used to track the movement and interactions of dysbindin, Wave-2, and Api-1 proteins during neurogenesis. The role of dysbindin during neurogenesis in stabilization and organization of actin was determined by comparing immunofluorescence in control and dysbindin knock-out neurite outgrowth assays.

IMPACT OF ACUTE EXERCISE ON MICRORNAS RELATED TO CONCUSSION SYMPTOMS

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Concussions, or traumatic brain injury (TBI), are a serious medical problem affecting approximately 1.7 million people in the United States each year. Current tools for analysis of concussion include the Glasgow Coma Scale, SCAT5, computerized topography (CT) and magnetic resonance imaging (MRI). However, these tools are typically not indicative of the range and severity of symptoms a patient may experience. Recent studies have explored the use of microRNAs as biomarkers for TBI symptom severity in patients who have already experienced a TBI. We seek to investigate select microRNA levels in response to an acute exercise stimulus in a healthy population in order to establish a baseline for these microRNAs in a healthy population. The use of these microRNAs as a valuable diagnostic tool for sport-related concussion is dependent upon their stability following exercise. Approximately 12 recreationally-active individuals between the ages of 19 and 45 will be recruited as participants in this study. Each participant will complete one exercise trial. Trials will consist of 1 h of cycling at 60% of maximal power output. 5 minutes before and 5minutes after the exercise session, blood and saliva samples will be collected. 5 mL of blood will be drawn from the antecubital vein, and saliva will be collected by having the participant expectorate into a collection tube. MicroRNAs of interest will be quantified in the plasma and saliva using qRT-PCR. Expired gases will be collected during exercise for determination of exercise intensity using a flow and gas concentration calibrated metabolic cart. Data collection is planned for the summer and fall of 2020.

IDENTIFICATION OF DIFFERENTIALLY EXPRESSED LONG NON-CODING RNAS IN MURINE MICROGLIA IN RESPONSE TO LPS

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Activated microglia function in the central nervous system (CNS) as immune responsive cells. The pro-inflammatory state of microglia can cause cytotoxicity in the CNS and is associated with several disease states. Consequently, understanding the mechanisms that control the pro-inflammatory state of microglia is of great interest. LncRNAs are functional RNAs that do not encode proteins but help facilitate gene regulation. Certain lncRNAs may be important regulators of the pro-inflammatory state of microglia. Our hypothesis is that upon activation by pro-inflammatory stimuli, such as LPS, microglia differentially express a set of lncRNAs that enhance the immune response. We used a genome-wide microarray analysis of LPS stimulated microglia compared to control microglia. Upon analysis, we identified several upregulated lncRNAs and validated the results using RT-qPCR. After stimulating the BV2 murine microglial cell line with LPS for 6h, there was a significant increase in the expression of lncRNA-25B, GM14005, AK15331, as well as the positive controls previously reported in literature to be induced by LPS stimulation, lincRNA-Cox2 and lincRNA-Tnfaip3. Similarly, we stimulated primary microglia with LPS and observed a significant increase in lncRNA-25B, GM14005, and lincRNA-Cox2. We selected lncRNA-25B for further analysis and characterization because it is induced higher than GM14005. In order to study lncRNA-25B expression in more detail, BV2 cells were stimulated with pro-inflammatory and anti-inflammatory cytokines over a time course of 24h. The results showed a significant increase in lncRNA-25B expression in response to LPS, Poly(I:C), and IFN-γ, peaking at 6h, and TNF-α peaking at 2h. There was no significant differential expression in response to IL-4, an anti-inflammatory stimulus. Interestingly, the expression levels for all treatment groups were not significantly

different than control at 24h, suggesting that lncRNA-25B acts early in the immune response. Identification of lncRNAs that modulate the inflammatory response could provide a novel target for pharmaceutical therapeutics.

A NOVEL LONG NON-CODING RNA MODULATES INFLAMMATORY GENE EXPRESSION IN MURINE MICROGLIA THROUGH INTERACTION WITH NF-KB P65

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After successfully cloning the full-length sequence of lncRNA-25B, we performed functional studies in which we overexpressed or used siRNA to knockdown the lncRNA-25B. After stimulation with LPS, murine microglia with lncRNA-25B knockdown showed decreased expression of inflammatory mediators (iNOS, Ccl2) compared to a scrambled siRNA control. Conversely, overexpression of lncRNA-25B enhanced the induction of iNOS and Ccl2 upon LPS stimulation when compared to empty vector control. Given that these are both NF-κB target genes, we used RNA immunoprecipitation to test for a physical interaction between lncRNA-25B and NF-κB p65. In a basal state, we detected no enrichment of lncRNA-25B associated with NF-κB p65 compared to IgG control, however, upon LPS stimulation there was a significant enrichment of lncRNA-25B with NF-κB p65 compared to IgG control. Together, these data begin to show the molecular mechanism of inflammatory gene regulation by a novel lncRNA, which could prove useful for the design of pharmaceutical therapies aimed at limiting neuroinflammation.

EFFECTS OF CURCUMIN ON THE NF-KB PATHWAY IN TRIPLE NEGATIVE BREAST CANCER

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Triple negative breast cancer (TNBC) is an aggressive form of breast cancer that occurs in 10-20 % diagnosed breast cancer cases. TNBC lacks estrogen, progesterone and overexpression of HER 2 receptors making current molecular target therapies ineffective. Numerous studies have shown the effect of curcumin, a natural extract of turmeric spice showing anti-cancer properties by decreasing cancer cell proliferation. Current study analyzes the effect of curcumin on NF-κB pathway by a possible regulatory mechanism of IKKβ. TNBC cell line MDA-MB-231 was used. MDA-MB-231cell line was treated with different concentrations (0-80 μM) of 7mM of curcumin for 24 hour and MTT assay was used to analyze percentage proliferation and cell viability after the treatment to. Treatment of TNBC cell line by 40uM of curcumin decreased cell survival by 95.8% after 24 hours of treatment. The specific target of curcumin in the NF-κB pathway will be assessed using Western blots and RNAi knock-out.

CHARACTERIZATION AND IN VITRO ASSESSMENT OF A CNS TARGETED NANOFORMULATION OF DOLUTEGRAVIR

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It is well established that combination antiretroviral therapies (cART) are highly effective in both reducing HIV infections and AIDS-related deaths. Despite this, HIV continues to be one of the most prevalent worldwide viral infections. This is in-part due to known challenges associated with chronic cART. HIV-associated neurocognitive disorder (HAND) continues to be a significant clinical outcome for HIV-infected individuals due to low-levels of viral replication within the CNS. Studies

have also shown that up to 6% of patients experience peripheral neuropathies from chronic exposure to the popular cART drug, dolutegravir (DTG). DTG is an effective integrase inhibitor with markedly low viral mutation rates among patients, though a significant number are eventually forced to discontinue DTG use due drug-induced neuropathies. We are investigating the potential for modified poly(lactic-co-glycolic acid) (PLGA) nanoparticles to be utilized as a trans-blood-brain barrier vehicle for efficient and less cytotoxic DTG delivery. We propose human holo-transferrin-conjugated(hhTf) PLGA-DTG-NP may reduce drug cytotoxicity and have observed NP entry into various CNS cell lines. Cell viability was shown to be increased using NP treatments across multiple cell-lines when compared to DTG solution at the same concentrations. Cell viability in hhTf-DTG-NP treated SHSY5Y neurons was >20% higher than in DTG solution treatments at 24hr and 48hr ($p<0.0001$) but not at 96hr ($p>0.05$) between 10, 1, 0.1, 0.01 ug/mL. Between DTG solution and DTG nanoparticle treatments, BV2 microglia showed >50% higher viability at 24hr and 48hr ($p<0.0001$) at all tested concentrations and by 20% at 96hr below 1ug/ml ($p<0.0001$). Preliminary ELISA assays showed no significant release of inflammatory cytokines IL-6 and TNF-alpha between DTG conditions in SHSY5Y cells. RTPCR analysis for inflammatory cytokine production in DTG solution and DTG NP treatments are on-going.

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GENE EXPRESSION OF PRIMARY CORTICAL ASTROCYTES WHEN TREATED WITH DOLUTEGRAVIR ENCAPSULATED IN HUMAN HOLO-TRANSFERRIN NANOPARTICLES

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Dolutegravir (DTG) is an integrase strand transfer inhibitor (INSTI) used frequently in combination with other antiretrovirals (ARVs) as a first-line treatment for HIV. Despite its success, reservoirs such as the central nervous system (CNS) accumulate HIV due to difficulty of ARVs crossing the blood-brain-barrier (BBB). Along with other ARVs, long-term use of DTG is associated with negative neurological effects linked to the inflammatory responses of brain cells. Brain-targeted nanoparticles encapsulating DTG may provide a safe, highly efficacious means to reduce HIV reservoirs in the CNS while also reducing inflammatory responses. This project is designed to determine whether human transferrin receptor (hTf)- targeted brain nanoparticles (NP) reduce the inflammatory responses of brain cells by looking at the expression of common cytokines associated with inflammation. Astrocytes are the most abundant cells of the brain and are vital for support of neurons. Astrocytes are capable of cytokine production. Thus, primary cortical astrocytes were treated with hTf-DTG-NPs over the course of 24 hours and 48 hours. Reverse transcription polymerase chain reaction was then utilized to measure the expression of inflammatory cytokines. Preliminary data suggests that DTG in solution tends to upregulate cytokine expression while hTf-DTG-NPs show reduced expression of those same cytokines. The results should determine whether or not hTf-DTG-NPs are likely to provide a safer alternative to DTG alone.

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EFFECT OF AMBIENT TEMPERATURE ON BLACK SWALLOWTAIL TERRITORIALITY

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Black Swallowtail butterflies (*Papilio polyxenes*) are a prairie habitat specialist species common in Nebraska. They are well known for males exhibiting "hill-topping" territoriality, in which males compete to hold territories in high elevation locations within prairies, to which females move when seeking mates. In the summer of 2019, I observed the hill-topping behavior of male Black Swallowtails at several locations at Glacier Creek Preserve, a restored prairie in Bennington, Nebraska, owned and managed by the University of Nebraska at Omaha. I recorded the number of interactions as well as the durations of male-male interactions and of male perching behavior on the hilltops. Using weather records from weather stations at G. C. P., I looked for effects of temperature, wind speed & direction, and relative humidity on the territorial behavior. I found significant effects of temperature on number of interactions overall, with no differences between hilltops. Perching duration between fights was variable; there were no significant effects of temperature, but a non-significant trend for different durations between the different hilltops. With ongoing climate warming, such temperature-dependent effects on behavior may have consequences for habitat specialists such as the Black Swallowtail.

BUTTERFLY FLOWER VISITORS AT GLACIER CREEK PRESERVE: A PHOTOGRAPHIC CATALOG

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Since 2012, in conjunction with weekly transect Butterfly population counts, 9,560 flower visits by butterflies have been recorded at Glacier Creek Preserve, a restored prairie in Bennington, Nebraska, owned and managed by the University of Nebraska at Omaha. In the summer of 2019, accompanying the transect counts, I conducted an intensive photographic sampling of flower visits by the preserve's butterflies, using a cellphone camera. Photographs were obtained of 20 butterfly species visiting 19 species of flowers, with some combinations quite frequent and others less so. Representative examples will be presented. The photographs acquired were compiled into a catalog that will be posted on the G. C. P. website, for use by researchers and public visitors of the Preserve.

PLASTICITY IN FEMALE MATING BEHAVIOR IN GREEN SWORDTAILS

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Phenotypic plasticity is the ability of an organism to adaptively alter its phenotype in response to internal or external stimuli. Reproductive plasticity is a type of plasticity in which an organism can adjust parameters such as rate or timing of progeny production, or mating behavior, to maximize successful reproduction. Mating behavior is often influenced by local environmental conditions such as the presence of conspecifics or the presence of a predator. In this study, we investigate how female green swordtails (Xiphophorus helleri) respond to male mating behaviors in the presence and the absence of a predator. Xiphophorus are freshwater, live-bearing fishes that have been studied extensively since the early 1800s, resulting in a wealth of information about Xiphophorus biology. In addition, Xiphophorus has been developed as a major animal model to address human health issues, and, is one of the top five model animal systems for gene mapping. Female experimental trials are conducted in a 40”x12”x12” 15-gallon tank with a 2”x2” grid at the bottom to quantify the fish movement throughout the tank. Three plant refuges are equidistant from one another at the surface of the tank. The top and front views are filmed to be subsequently scored. Before each trial, the test subject is exposed to either a predator

present or a predator absent environment for ten minutes. Each trial is 40 minutes in length. This study will determine whether female Reponses to male traits change in the presence of a predator; that is, whether females show phenotypic plasticity in mating behavior.

EFFECT OF FOOD DEPRIVATION ON ANXIETY-LIKE BEHAVIOR IN MICE

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Anxiety symptoms are associated with disturbances of the emotional centers of the brain, such as the amygdala, and can cause behavioral changes. Many behaviors, including anxiety-like behaviors displayed by animals, are affected by its nutritional state. An animal's nutritional state consists of both the quality of food available and the amount of food available. Food deprivation of 24 hours has been shown to alter reproductive behaviors in rodents. As such, it is possible that it may also affect anxiety-like behaviors. Subjects for this experiment are wildtype males, wildtype females, and testosterone feminization mutant mice, which are male mice that lack a functional androgen receptor (AR) due to a mutation, who are tested for anxiety-like behavior using an elevation plus maze (EPM). We predicted that food-deprived mice would spend a greater percentage of time in the closed arm of the EPM relative to mice that had continuous access to food. Preliminary data support this prediction. We also predict changes in neural activity in food-deprived mice in brain regions associated with anxiety, such as the amygdala.

EFFECT OF SELF-GROOMING BEHAVIOR ON CFOS IMMNUOREACTIVITY IN THE MOUSE MEDIAL AMYGDALA

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Self-grooming behavior is observed across many animal species and has numerous functions. One such function is to attract and indicate interest in a conspecific as a potential mate. It is unknown if the presence of androgen receptor (AR), which binds testosterone, affects the amount of time that mice spend self-grooming in response to olfactory cues from conspecifics. Furthermore, few studies examine neuronal activation following a bout of self-grooming behavior. Therefore, we hypothesized that the amount of cfos-positive cells, which acts as a marker of neuronal activation, is affected by the AR status of the groomer and conspecific odor donor. We predicted that there will be more positive cells present in the medial amygdala (MeA) when wild-type (wt) female and testicular feminized mutant (tfm) mice, genetic male mice without functional AR due to a mutation, are introduced to the odors of a wt male, whereas there will be more positive cells present in the MeA of wt male mice upon exposure to odors from a wt female. Such predictions are based on previous studies that have shown AR's role in the sexual differentiation of responding to olfactory signals.

MOLECULAR SUBCLONING, EXPRESSION AND FUNCTIONAL CHARACTERIZATION OF HUMAN TRANSFORMING GROWTH FACTOR BETA TYPE 1 TO DECIPHER THE ROLE IN ANTIRETROVIRAL PHARMACOLOGY

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Human Immunodeficiency Virus [HIV] remains an infectious disease killer globally. This disease affects approximately 37 million people globally and many undergo treatment termed antiretroviral therapy. Despite many advances in antiretroviral therapy, there is no viral eradication of the disease from viral reservoirs. By focusing on improved pharmacokinetics, antiretroviral treatment may be improved.

It has been shown transforming growth factor beta type 1 [TGFB1] reduces penetration of anti-HIV drugs into human lymphoid endothelial cells [known viral reservoirs]. To test continuing hypotheses, we outline and summarize recent explorations of the TGFB1 methods, lessons, and results of molecular subcloning targets of the gene of interest.

STRUCTURAL ANALYSIS OF KAPOSI'S SARCOMA-ASSOCIATED HERPESVIRUS PAN RNA

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Kaposi's sarcoma-associated herpesvirus (KSHV) is a herpesvirus linked to Kaposi's sarcoma and two forms of lymph node cancer. KSHV infects cells and replicates its viral genetic material, creating an RNA transcript with no known protein coding function known as polyadenylated nuclear RNA (PAN RNA). PAN RNA has been shown to associate with multiple transcription related complexes that promote lytic replication including k-Rta, the driving transcription factor of the KSHV lytic cycle. PAN RNA also associates with host cell machinery to prevent immune response to KSHV infection. Analysis of the structure of the PAN RNA molecule gives perspective on how the molecule performs its role in the lytic cycle. The selective 2'-hydroxyl acylation analyzed by primer extension with mutational profiling (SHAPE-MaP) method chemically modifies the molecule, converts it into cDNA wherein modified nucleotides generate mutations. By sequencing the molecule, the shape of the molecule can be determined through algorithmic analysis. Using the exceptionally accurate SHAPE-MaP method to analyze PAN structure will refine the current understanding of the secondary structure of the molecule.

PERSISTER FORMATION IN STAPHYLOCOCCUS EPIDERMIDIS

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Staphylococcus epidermidis is a gram-positive bacterial species that normally colonize on the skin of humans and mammals. As an opportunistic pathogen, S. epidermidis causes infection in individuals through hospital-acquired indwelling medical devices. In recent a study, it concluded that S. epidermidis caused over 50% of medical device infections located in the main joints and limbs. Antibiotic treatment of these infections is often unsuccessful, leading to chronic, relapsing infections that often lead to the removal of the medical device. A likely explanation for the underlying cause of these relapsing infections is persister cells, which are dormant, phenotypic variants of bacterial cells that show tolerance to an antibiotic. Recent research on the related pathogen, S. aureus, demonstrates persister formation is likely dependent on energy depletion through a disrupted tricarboxylic acid (TCA) cycle. To test our hypothesis that S. epidermidis has a similar mechanism of persister formation through decreased TCA cycle activity, we used ethyl methanesulfonate (EMS) mutagenesis on the 1457 strain of S. epidermidis. Creating random mutations in the genome, we have seen half of a log increase in tolerance to the antibiotic vancomycin through enrichment of the EMS-treated strain compared to the 1457 wild type. Upon further enrichment of antibiotic tolerance in the EMS-treated strain, we will send the isolates for sequencing to identify possible mutations that are the cause of the high persister formation. These experiments will identify a mechanism of persister formation and determine whether a conserved mechanism exists between S. aureus and S. epidermidis or whether a unique mechanism of persister formation exists in S. epidermidis.

USING SACCHAROMYCES CEREVISIAE TO SCREEN FOR MAMMALIAN PROTEINS WITH INSULATOR PROPERTIES

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Specific inhibitory histone modifications like H3K9me3 are identified by their ability to spread down chromatin fibers. This action explains the ability of heterochromatin to expand into adjacent regions of DNA and silence nearby genes. However, this process is halted by insulator elements and the proteins that bind to them. Although many proteins with insulator function have been identified in yeast and flies, only CTCF has been identified as an insulator protein in mammalian cells. Here, we test a possible screening strategy in Saccharomyces cerevisiae to discover other mammalian insulator proteins. The system features two genes that have moved to a sub-telomeric region, which is kept silent by the position effect. Between these two genes lies a region containing a binding site for the yeast Gal4 transcription factor. Candidate proteins can be directed to this site through fusion with the Gal4 DNA binding domain. Candidates with insulator function will stop the spread of heterochromatin, thereby allowing the more distant gene to activate. Candidates without insulator function will fail to stop the spread of heterochromatin, leaving the more distant gene silent. Though this strategy has previously shown promise, we find that orthologs of CTCF respond differently in the system, despite their extremely conserved sequences.

CHARACTERIZATION OF STAPHYLOCOCCUS LUGDUNENSIS BIOFILMS

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Staphylococcus lugdunensis, which, not unlike Staphylococcus aureus and Staphylococcus epidermidis, can be found on human skin as normal flora. While S. aureus has been the primary focus of the medical community, there are new concerns that S. lugdunensis has been responsible for biofilm-induced infections, similar to those caused by S. aureus and S. epidermidis. With more accurate testing available, medical professionals are now able to distinguish S. lugdunensis from other coagulase negative bacteria. This has led to a greater appreciation for this organism as a major human pathogen. Contributing to the pathogenic nature of this organism is its ability to form a biofilm, which is the culprit of severe prosthetic joint infections, as well as cases of endocarditis. Based on similarity to the closely related pathogen, S. aureus, we hypothesized S. lugdunensis primarily formed protein mediated biofilms. To investigate this hypothesis, we compared the susceptibility of the biofilms to proteinase K. Following proteinase K treatment, S. lugdunensis biofilms were dispersed, indicating they form protein mediated biofilms. We then set out to identify genetic factors essential for biofilm formation in S. lugdunensis. We mutagenized a S. lugdunensis culture by treating with ethyl methanesulfonate (EMS). Following mutagenesis, individual cells were separated using a cell sorter and examined for biofilm formation at eight hours and 24 hours. Mutations resulting in high biofilm and low biofilm formers were sequenced to identify genes responsible for the biofilm phenotypes. A mutation within the S. lugdunensis surface protein A (slsA) gene was common among all of the low biofilm formers suggesting high expression of this protein is important in biofilm formation. Currently, a genetic knockout is being constructed to confirm these results. These results will shed light on the underlying mechanism of biofilm formation in this emerging pathogen.

DEVELOPMENT OF A SYSTEM TO SELECTIVELY RECRUIT AND STUDY CHROMATIN ARCHITECTURAL PROTEINS

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Chromatin is organized by architectural proteins that can alter chromatin to be in a tightly packed region of heterochromatin, in which genes are typically silenced, or to loosely organized regions of euchromatin, in which genes are readily expressed. What remains unclear is what precise formation and in what amount of time do these architectural proteins alter the chromatin. In order to understand how these architectural proteins work, we have developed an inducible heterodimerization system which allows for chromatin architectural proteins bound to a fluorescent tag to be specifically and selectively recruited to a stable genomic integration of 256 tandem repeats of the lac operator in CHO cells. Fluorescent microscopy is used to monitor how the architectural proteins are affecting the DNA by using different colored fluorescent tags on the proteins and on the chromatin itself. We have created a series of custom plasmids that encode for parts of our inducible heterodimerization system, and that have demonstrated that it has the ability to successfully recruit a chromatin architectural protein to the lac operator array in live cells.

RE-EXAMINATION OF FILAMENTATION REQUIREMENTS OF C. ALBICANS IN LOG AND POST DIAUXIC PHASE

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Candida albicans is a commensal fungus normally found within the human microbiome. Despite its normally neutral presence, *C. albicans* is an opportunistic pathogen when the host's immune system and its neighboring microbiota are unable to keep it in check. Systemic infections by *C. albicans* in immunocompromised individuals are potentially fatal due to difficulty in clearance of the fungus with current medications. This pathogenicity in *C. albicans* is heavily reliant on its ability to filament and transition between yeast and hyphal states. Filamentation is known to require the absence of quorum sensing factors like farnesol and the presence of inducing conditions. However, a third factor may be required for filamentation. Our data suggests that there is a third trigger for filamentation, that cells must be in post-diauxic phase prior to induction in order to filament. Cells were assessed for filamentation at 3, 6, and 9 hour time points starting with either log phase or post-diauxic phase cells in inducing conditions. Cells grown in inducing conditions from log phase cells failed to grow as true hyphae in any inducing condition tested, although pseudohyphae were observed in some inducing conditions. Our study highlights how much we still have to learn about the process of filamentation in *C. albicans* and our findings have larger implications for current drug functionality.

PREPARATION AND CHARACTERIZATION OF HYDROPHILIC POLYMER-LIPID COMPLEXES OF PHYTOCHEMICALS COMBINATIONS

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Space exploration places astronauts at an increased risk for oxidative stress related disease, cancer, and many other inflammatory related disease processes. These risks are not limited to astronauts, a study on potent antioxidants derived from phytochemicals is a benefit to society in general. Oxidative free radicals place added stress on the human body at a chemical level. Attacking these free radicals with phytochemicals like curcumin, quercetin, piperine, and resveratrol, all with known antioxidant

properties is a safe way to target the free radical while leaving healthy cells in-tact. However, these phytochemicals are poorly soluble in water, which leads to a greatly reduced bioavailability. The main objective of current research is to formulate and characterize these poorly soluble phytochemicals and their combinations using hydrophilic polymers and lipids to enhance their bioavailability. Solid lipid nanoparticles of curcumin-quercetin-polymer in different ratios were prepared by combining curcumin with quercetin dispersed in the compitrol (lipid) and Poly Lactic-co-Glycolic Acid (PLGA) polymer using a solvent evaporation method. The solid-state characterization of these formulations was carried out using Fourier Transform Infrared spectroscopy (FTIR) and X-Ray Diffraction (XRD). Stability of formulations in various physiologically relevant medium at room temperature was carried out. The in vitro release of curcumin and quercetin was carried out with Slide-A-Lyzer Dialysis Cassettes. At defined time points samples were drawn from the receptor compartment for analysis using High Performance Liquid Chromatography (HPLC). Presence of curcumin and quercetin in the formulations were confirmed by UV-Vis spectroscopy and HPLC. HPLC methods for the simultaneous detection of curcumin and quercetin was developed and validated. The Slide-A-Lyzer dialysis study results showed a continuous release of drugs from nanoparticles over time period of 24hours. Nanoparticles containing curcumin and quercetin showed long term stability and enhanced solubility but need to be further optimized for their synergistic antioxidant and cytotoxic capabilities.

EFFECT OF DIETARY PROTEIN CONTENT ON THE RESPONSE TO OVER-MARKS AND ANDROGEN RECEPTOR EXPRESSION IN MICE

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In both humans and rodents, males outperform females in tasks measuring spatial memory, suggesting a role for gonadal steroid hormones. A rodent's ability to discriminate between the top- and bottom-scent donors of an over-mark is an example of spatial memory. Previous research has indicated that meadow voles fed a low-protein diet or that have been food-deprived spend similar amounts of time investigating the scent donors of an over-mark. Interestingly, these treatments also result in lower estradiol levels in female voles. However, it is unclear if this lack of preference associated with dietary changes is due to cognitive defects linked to the diet or decreased interest in opposite-sex conspecifics due to lower gonadal hormone levels. Therefore, this study tested the hypothesis that the protein content of the diet affects an individual's spatial memory in a mouse model that lacks androgen receptors (AR). Mice were fed either a high- or low-protein diet for 30 days and then exposed to an over-mark to test spatial memory. Brain activity in response to over-mark exposure was determined by measuring c-Fos expression in brain areas associated with both spatial memory and processing olfactory signals, such as the hippocampus and medial amygdala. AR expression was also measured in these areas. We predicted mice fed a high-protein diet will show a top-scent preference and express higher levels of c-Fos and AR in the measured brain regions. This would suggest that protein content of the diet works through AR to modulate spatial memory.

THE ROLE OF SPERMINE IN CELL GROWTH, CELL MAINTENANCE, AND GENE EXPRESSION

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Riboswitches are segments of messenger RNAs (mRNAs) that bind to specific cellular metabolites and regulate gene expression. Riboswitches are defined based on the following criteria: the RNA binds specifically to one metabolite, the RNA exhibits conformational changes induced

by metabolite binding, and the RNA influences gene expression in a metabolite-dependent manner. Although nearly all discovered riboswitches are in bacteria, fungi, and plants, the Soukup lab has identified a putative mammalian riboswitch: an RNA pseudoknot that appears to bind specifically to spermine, exhibits spermine-dependent conformational changes, and affects spermine-dependent expression of Ornithine Decarboxylase Antizyme 1 (OAZ1), an inhibitor of spermine biosynthesis. My objective is to confirm that spermine binding to the OAZ1 RNA and subsequent structural changes affect gene expression in a metabolic-dependent manner. I have investigated this using dual luciferase reporter assays. In addition, I am exploring the effect of spermine and other analogs on cell growth and maintenance. Investigating the role of the OAZ1 RNA in controlling gene expression will greatly aid in future studies focused on studying how this mammalian riboswitch may be a potential target for drugs to affect a metabolic process key to cancer cell growth and proliferation.

MOONLIGHTING EFFECT OF REDUNDANT METHYLGLYOXAL DETOXIFYING PATHWAYS IN CRABTREE POSITIVE AND NEGATIVE YEASTS

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In Saccharomyces cerevisiae, the Crabtree effect has been observed for nearly a hundred years. Crabtree positive yeasts, like S. cerevisiae, are characterized by a preference towards glycolysis, rather than the TCA cycle and subsequent ATP generation via respiration. Crabtree positive yeasts maintain glycolysis and fermentation even in aerobic environments with high external glucose. The reason for this phenomenon has only been theorized. However, the increased production of ethanol and the ability to withstand high ethanol may have evolved as a competition mechanism among microbes due to the antimicrobial properties of ethanol (Thomson JM, et al. 2005). This decision by Crabtree positive yeasts does not come without consequence, as increased glycolysis and fermentation results in higher production of glycolysis-derived reactive species, such as methylglyoxal (MG). MG is mainly detoxified via the glyoxalase system, notably the conventional glutathione (GSH) dependent glyoxalase 1 (glo1) and glyoxalase 2. Recent research has discovered other contributing GSH-independent pathways, such as glyoxalase 3 (DJ-1/Hsp31) (Hasim S, et al. 2013) and alcohol dehydrogenase (ADH) (Kwak MK, et al. 2014). I hypothesize that these less prominent pathways provide the additional detoxifying activity required for Crabtree positive yeasts to sustain high glycolysis utilization and growth in ethanolic environments. My research will knock out these pathways in both Crabtree positive (S. cerevisiae) and negative (Candida albicans) yeasts, test the growth of these mutants in ethanolic and MG growth conditions, and utilize proteomic analysis to confirm the impact of these redundant pathways. Additionally, results from this research may be valuable in understanding the Warburg effect in some tumor cells, since they too are characterized by a similar glycolysis and fermentation preference, accompanied by increased MG production.

NANOPARTICLES FOR SIMULTANEOUS ASSESSMENT OF ROS AND RADIOSENSITIZATION OF BRAIN CANCER CELLS

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Glioblastoma is the most common primary brain tumor in adults and yet it remains one of the least treatable. Current standard of care which involves combinations of surgery, radiotherapy and chemotherapy, results in a median survival of only 15 months. This dismal outcome is partly due to the high radio-resistance of Glioblastoma. Here, we seek to enhance radiotherapy outcomes through radiosensitization using nanoparticles such as quantum dots and carbon dots.

Having recently published our novel assay wherein we used fluorescence intensity modulation of CdSe/ZnS quantum dots (QDs) to assess reactive oxygen species (ROS) generation during chemotherapy and radiotherapy for cancer cells, we are applying this assay for concurrent measurement of ROS and radiosensitization. Using a Faxitron Cell Irradiator, we irradiate brain cancer cells (T98G and U87 Glioblastoma cells) treated with QDs and measure both their migration and the QD fluorescence intensity. We measure and quantify the migration using a commercially available Electric Cell Impedance Sensor (ECIS)

Irradiated T98G cells attach and migrate significantly ($p<0.0001$) more than non-irradiated cells in the first 20 hours post irradiation. Preliminary results also show that the radiotherapy leads to QD intensity reduction due to ROS production as expected. Results for radiosensitization will be presented.

NON-INVASIVE OPTICAL QUANTIFICATION OF STRUCTURAL AND FUNCTIONAL CHANGES OF COLLAGEN IN CHRONIC-UVA-EXPOSED SKIN

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Collagen is the main structural protein in the extracellular matrix and is the main component of connective tissue. Collagen's specific function is to provide strength and elasticity to the skin, tendons, ligaments, and other tissues in the body. When exposed to UVA radiation, the healthy fibrous collagen is broken down and reformed in an irregular pattern by fibroblasts trying to repair the tissue. A different form of collagen remodeling also occurs with the development of cancer. Collagen, when excited by single-photon UV light or multi-photon near-infrared light, emits fluorescence and can be imaged by laser scanning microscopy. Similarly, collagen can also be imaged using second harmonic generation of intense pulses of near-infrared light. We designed a custom in vivo microscope and conducted a longitudinal study of chronically UVA-exposed SKH1 mice to determine whether these techniques will be useful as an approach for non-invasive optical biopsy. Results and future approaches to the quantitative analysis of collagen structure in vivo will be discussed.

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MEASUREMENT OF CELL MECHANICAL PROPERTIES POST-CHEMOTHERAPY FOR THE PHYSICS OF CANCER

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Purpose/Rationale: In our recent publication, "Chemotherapy impedes in vitro microcirculation and promotes migration of leukemic cells with impact on metastasis", in Biochemical and Biophysical Research Communications, (Prathivadhi et al., 2016) we showed that Doxorubicin and Daunorubicin, commonly used anti-cancer drugs, stiffen cells before causing cell death, predisposing the cells to clogging and extravasation, the latter being a step in metastasis. We are taking further steps to find out which other anti-cancer drugs might have similar effects.

Methods: We treat leukemic (HL60) and erythroleukemic (K562) cancer cells with the drugs Nocodazole, Paclitaxel, Imatinib and Lenalidomide, and then measure their mechanical properties using

the microfluidic microcirculation mimetic (MMM) device, which mimics aspects of blood circulation (pulmonary microcirculation) and enables the measurement of cell mechanical properties via transit times through the device. We also measure the migration of cells thus treated to determine the functional relevance of the MMM results.

Results: Preliminary results from MMM measurements show that Paclitaxel and Nocodazole treated HL60/K56 cells exhibit significantly altered transit times. Other results will be presented.

IDENTIFYING PROTEIN EXPRESSION CHANGES IN ACUTE MYELOID LEUKEMIA

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Acute myeloid leukemia (AML) is a devastating cancer affecting the hematopoietic system. It is characterized by infiltration of abnormal proliferating immature myeloid cells originating in the bone marrow. Although this disease represents only 35% of diagnosed leukemias, it accounts for nearly 50% of leukemia-related deaths, making it the leading cause of leukemia-related mortality. Disease initiation often occurs through common recurrent genetic aberrations resulting in the formation of oncogenic fusion proteins. Two common mutations include mixed lineage leukemia (MLL) rearrangements and an inversion of chromosome 16, known as Inv(16). Although many of these AML initiating mutations have been identified, the downstream effects leading to disease progression are still largely unknown. Previous research has relied on RNA sequencing and microarray techniques to study the downstream effects, providing data at the transcriptional level. While these studies have proven efficacious, they fail to capture the changes that occur at the proteomic level. To interrogate the effect of protein expression alterations in AML, we performed a quantitative mass spectrometry (MS) analysis using mouse models to compare three tumor types (Inv(16), MLL-AF9, and MLL-ENL) to untransformed cells from the tumor-initiating population. In parallel, we performed RNA sequencing for the same populations. With these combined results, we identified 61 proteins whose expression was upregulated in AML tumors, but strikingly, were unaltered at the transcriptional level. These proteins are shown to be associated with mitochondrial function as well as RNA processing. In addition, analysis of patient expression data sets in adult and pediatric AML reveal that a number of the proteins differentially expressed have no significant RNA expression alterations. These studies identify a set of proteins that have not previously been associated with leukemia, and may ultimately serve as potential targets for therapeutic manipulation to hinder AML progression and help contribute to our understanding of this disease.

INSULIN STIMULATION AFFECTS OPA-1 MEDIATED MERCS IN HUMAN AND MURINE SKELETAL MUSCLE CELLS

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Insulin responsive tissues in Type 2 Diabetes (T2D) and cardiovascular diseases have been shown to be associated with Mitochondria Endoplasmic Reticulum Contact sites (MERCs) communication. MERCs are membranes that are enriched with specific proteins believed to be significant for calcium signaling, lipid transfer, and mitochondrial morphology. Insulin resistance in T2D patients is associated with changes in mitochondrial oxidative metabolism in insulin responsive tissues. Although MERCs are known to be necessary for insulin signaling in the liver and skeletal muscle, it is not well understood whether MERCs influence the canonical cytosolic intracellular insulin signaling

pathways or intracellular insulin-signaling pathway proteins entrain the MERC interface to regulate metabolism. Previous studies have shown that insulin stimulation alters Optic Atrophy Protein-1 (OPA-1), an inner membrane mitochondrial protein, mediated mitochondrial fusion dynamics through an IR-AKT-MTOR- NFKB pathway and metabolism through Mitofusin-2 (MFN-2), an outer membrane mitochondrial protein, dependent mechanism. We hypothesized that insulin stimulation alters MERC's tethering through upregulating MNF-2 transcript levels to augment mitochondrial metabolism via IR-AKT-MTOR- NFKB specific intracellular signaling intermediate in human and murine cells. To test the hypothesis, we investigated mitochondrial dynamics, cristae morphology, and MERCs changes with insulin stimulation and ablation of OPA-1 using TEM analysis in murine and human cells. We found that outer membrane mitochondrial fusion occurred after two hours of insulin stimulation in murine and human cells. A deletion of OPA-1 resulted in structural changes of the mitochondria and fragmentation in murine cells. Interestingly, insulin stimulation in two hours in murine cells with OPA-1 ablation also promotes inner membrane mitochondrial fusion. Additionally, two hours of insulin stimulation induced a decrease of MERCs with or without OPA-1 in murine cells. However, two hours of insulin stimulation has no significant effect on MERCs in human cells. The results suggested that although insulin stimulation promotes outer membrane mitochondrial fusion and increase cristae integrity, outer membrane mitochondrial fusion happened independently from OPA-1. Thus, it is presumed that MFN-2 is responsible for the outer membrane metabolic phenotypes.

COLOCALIZATION OF HYPOTHETICAL CHAPERONE PROTEINS WITH DOTA WITHIN THE PATHOGENESIS OF COXIELLA BURNETII

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Coxiella burnetii is a zoonotic intracellular pathogen causing human Q-fever. To infect eukaryotic cells and establish a replicative niche termed the parasitophorous vacuole (PV), C. burnetii requires a type IVB secretion system (T4BSS). The essential T4BSS component, DotA, is secreted from the bacterial cell and colocalizes with the PV membrane and may interact with host components to direct the establishment of the PV. It is unknown how DotA is regulated in the bacterial cell cytoplasm prior to infection. We have previously conducted a protein screen to identify molecules that potentially interact with DotA when C. burnetii is not grown in the presence of lipids. Three potential DotA interacting proteins, CBU_0351, CBU_1078, and HlyD were determined to most likely interact with DotA. To determine specific interactions with DotA, the candidate genes and SecB, which was used as an alternative pathway control, were fused to a 3xFLAG tag under the control of a tetracycline inducible promoter when cloned into a C. burnetii expression vector. Crude bacterial lysates of secB-FLAG expressing C. burnetii were analyzed by western blot and indicates SecB does not interact with DotA. Elucidation of a DotA regulator could be used as a vaccine target.

CHAETOGASTER INTENSITY AND PREVALENCE AT THREE SITES IN PINE RIDGE, SOUTH DAKOTA OVER FOUR YEARS.

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The purpose of this poster will be to present an analysis of intensity and prevalence of Chaetergasters in infected Physa snails over the course of four years at 3 different sites- Lacreek, Yellow Bear Dam, and Kyle Dam- at Pine Ridge, South Dakota. We investigated the correlation between the size of the infected snail and the number Chaetergasters found in its host. We also looked at the overall trend of the Physa sizes over the course of the last four years. Data was collected by sectioning off a 1 by 3 meter transect at each site and collecting snails for a 15-minute period. The snails were taken

back to the lab and placed into individual well plates for 48 hours. They were then identified by genus, measured, and dissected under a dissecting microscope. The number of Chaetergasters were counted and recorded by each student performing the dissection. The results show that there an inconsistency in the relationship between the size of the infected Physa and the number of Chaetergasters found in their host. In addition, as the average size of the Physa found year to year fluctuates, this could be an indication that the population of snails at these sites are growing faster some years than others.

ASSESSMENT OF TICK-BORNE PATHOGENS IN THE TRI-CITY AREA OF CENTRAL NEBRASKA IN 2019

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Ticks are parasites that can live all over the world and feed off many different organisms, including humans and other vertebrates. They are capable of transmitting pathogens that cause both chronic and life-threatening tick-borne illnesses (TBIs). Reported cases of TBIs is on the rise in the US for a variety of reasons, and many cases likely go undiagnosed. Symptoms of TBIs include fever, headache, and rash. Blacklegged/Deer Ticks (Ixodes scapularis) transmit Borrelia burgdorferi, which cause Lyme Disease and are now established in limited areas of Nebraska, while Dog Ticks (Dermacentor variabilis) and Lone Star Ticks (Amblyomma americanum) both transmit several TBIs and are still the first and second most abundant ticks in the state, respectively. In this study, the goal was to identify tick species in the tri-city region and to quantify infectious bacteria prevalence. Two hundred twenty one adult ticks were collected at various locations within the tri-city area of Nebraska. They were sorted by sex and species, with 168 identified as D. variabilis (80 males, 88 females), 52 as A. americanum (26 males and 28 females), and one female Amblyomma maculatum, which transmit Rickettsia parkeri and some animal TBIs. It is still unknown if A. maculatum is established in Nebraska, but its range has been steadily expanding. DNA was extracted from each individual tick (minus the A. maculatum) using the Wizard Genomic DNA extraction kit. PCR and gel electrophoresis are currently underway to identify pathogenic bacterial DNA present in the ticks. Positive DNA samples will be sent to the UNMC Genome Core for sequencing.

ANALYSIS OF DRUG BINDING TO GLYCOFORMS OF ALPHA1-ACID GLYCOPROTEIN BY HIGH-PERFORMANCE AFFINITY CHROMATOGRAPHY

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Personalized medicine is a topic of growing interest for the effective treatments for patients. For instance, individual differences among patients can lead to changes in the efficacy for some drugs. To develop a personalized form of treatment in this case, the activity of drugs should be carefully monitored and the dosage adjusted according to this activity. One way of directly estimating the activity of a drug in the circulatory system is to use the drug's free, or non-bound, fraction. The free fraction of a drug often represents its biologically-active form, which makes this fraction of great interest in the pharmaceutical and clinical fields. Alpha1-acid glycoprotein (AGP) is a major transport protein and binding agent for many basic and neutral drugs in the bloodstream. AGP has five glycosylation sites and a molar mass that can range from 37-54 kDa due to variations in its carbohydrate chains. These variations in the carbohydrate chains can vary with a patient's disease status; however, little information is available on the impacts of these changes on drug binding by AGP. This study combined the use of ultrafast affinity extraction and high-performance lectin chromatography to measure the free fractions for various drugs in the presence of fractionated glycoforms of AGP, with goal of determining how strength of these interactions are changed by alterations in the carbohydrate groups of AGP. The global

affinity constants that were estimated by these methods for various drugs with two glycoform fractions were measured and compared. It was found that glycoform fractions that were separated by the lectin concanavalin A can have significant differences in their global affinity constants for some drugs. These results should be useful in providing a better understanding of how drug-AGP binding may change in diseases where changes in AGP glycosylation can occur.

QUANTIFYING CHRONIC UVA-INDUCED SKIN DAMAGE IN SKH1 MICE USING PHASOR-FLIM IMAGING AND IMMUNOFLUORESCENCE

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Skin cancer will impact 1 in 5 Americans by the age of 70, with excessive, chronic UV exposure the biggest risk factor in developing lesions such as squamous cell carcinoma, the second most common form. Early detection is key to effective treatment. To design a novel diagnostic tool for skin cancer, it is important to quantify inherent phenotypic differences between normal and cancerous cells. Cancer is characterized by a multitude of metabolic, architectural, and biochemical changes. Using phasor FLIM imaging of endogenous coenzymes NAD(P)H and flavoproteins, inherent metabolic differences in developing cancer cells can be probed non-invasively. These changes can be corroborated using traditional techniques such as histology and immunofluorescent staining for p53. Many studies have examined how acute UVB and UVC exposure changes skin morphology and induces cancer, but not many have looked at chronic UVA exposure, which resembles typical human exposure levels. Endogenous coenzyme binding conformations and intracellular p53 change with tumorigenesis, which can be quantified using phasor FLIM imaging and immunofluorescence, respectively. Identified tumor regions of skin had significantly higher amounts of p53 localized to both the cytoplasm and nucleus. Tumors, when imaged in vivo, also had significantly lower redox ratios and bound fractions of NAD(P)H overall. Phasor FLIM metabolic imaging of NAD(P)H verified using immunofluorescence staining of p53 together demonstrate the foundation and feasibility of a novel diagnostic technique for skin cancer.

THE INFLUENCE OF HEAT ON APPETITE REGULATING HORMONES

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Leptin has been established as an energy-controlling hormone because of its role in activating the JAK-STAT3 pathway. Exercising in the heat (1-hour of cycling @60% VO2max in 33°C) has also induced reductions in leptin. However, in order to better understand the influence of environmental temperature, independent of exercise, a fasted resting investigation is needed. This investigation explored the impact of environmental temperature (33 vs. 20°C) on adipose-derived appetite-regulating hormones (leptin and adiponectin) and energy expenditure. Ten college-aged males (27±5y, 86±13kg, and 183±4cm) completed two randomized, resting trials in the Heat (HT, 33°C) and in Room Temperature (RT, 20°C). Blood draws were taken pre-intervention and 3 h post-intervention for analysis of leptin and adiponectin. Oxygen consumption was measured at 1-, 2-, and 3-h timepoints. HT trial temperatures were greater than RT for core (37.17±0.08 vs. 36.89±0.08°C, $p=0.002$) and skin (37.59±0.10 vs. 32.65±0.48°C; $p<0.001$). Oxygen consumption was higher in HT than RT during the 2nd (4.37±0.14 vs. 4.13±0.15 ml/kg/min, $p=0.037$) and 3rd (4.95±0.26 vs. 4.28±0.19 ml/kg/min, $p=0.002$) hours. Fasting leptin concentrations in RT decreased to a greater extent than in HT (mean Δ±SEM; -2.05±0.83 vs. -0.89±0.74 ng/ml; $p=0.032$); however, after adjustment for plasma volume shifts (-7.5±4.2%) the interaction disappeared (mean Δ±SEM; -1.79±1.72 vs. -0.89±0.74 ng/ml; $p=0.068$). Heat stress increased energy expenditure and attenuated the normal reduction in leptin over time. These data may have implications for appetite control, weight management, and nutritional interventions during heat exposure.

USING BRED-CONSTRUCTED GENE KNOCKOUTS TO DETERMINE FUNCTIONS OF BACTERIOPHAGE GENES

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Bacteriophage, or phage, are viruses that infect and kill specific bacteria. Therefore, phage have the potential to be used as a replacement for antibiotics. This use of phage to treat bacterial infections is called phage therapy. One limitation to the broader use of phage therapy is that many phage genomes contain genes with unknown functions. Knowledge of these functions is important because we can better understand the process of infection and potentially engineer more effective phage. Bacteriophage Recombineering of Electroporated DNA (BRED) is a technique to mutate specific phage genes to determine if the genes are important for host infection and to help identify their functions. In this project, we will use the host bacteria Mycobacterium smegmatis and mycobacteriophage FudgeTart as a case study for BRED. To prepare M. smegmatis that can be used for recombineering, we first transformed the bacteria with pJV53, a plasmid that contains the genes for recombinase proteins which allow for replacement of a gene with a mutated version via homologous recombination. Then, we transformed the phage genomic DNA and a DNA oligo containing the desired replacement sequence into the recombineering M. smegmatis. The transformed bacteria was plated, and we screened the resulting plaques both visually and through PCR to check for mutations in the specific phage gene. Once the mutation was verified, we amplified the phage and created lysates for further experiments. The goal of this project is to establish an efficient process to perform BRED experiments at Doane University, using Doane's extensive collection of bacteriophage. If this experiment is successful, we can continue to use BRED on the phages in Doane's collection to better understand how phage work and whether they can be used efficiently for phage therapy.

VOLUTION OF A NUCLEAR rRNA INTRON IN PHYSCIA

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Introns have been found in all sequenced eukaryotic genomes, yet their origins are unclear. This is likely due to their antiquity and the lack of selective pressure, both of which results in high sequence divergence. This has made the location of convincing intermediate forms difficult. However, some of these issues appear to be mitigated in nuclear ribosomal RNA (nrRNA) in lichen forming fungi and close allies. Introns are particularly abundant in the genus Physcia. In this project, we focus on introns at two sites (1092, 1094) within the large subunit (LSU) rRNA gene. Previous work found that these introns never co-occur in the same repeat, but that they are both found in the genomes of at least 36 different isolates. Based on sequence similarity we hypothesized that the two introns share a common origin. In this study, we sought to expand the sample size by collecting and sequencing the intron from different isolates. However, until now neither intron has been found in any of the studied specimens. This has been confirmed using five sets of intron-specific primers in PCR. The next step is to re-visit some of the same locations as the previous study to determine if introns have been lost in these species or if intron presence/absence varies based on geographic location.

EVALUATION OF A NON-INVASIVE OPTICAL BIOPSY FOR THE EARLY IDENTIFICATION OF SQUAMOUS CELL CARCINOMA

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The development of neoplastic disease can be identified by changes in tissue architecture as well as a metabolic preference for glycolysis over oxidative phosphorylation. These changes can be observed by non-invasive monitoring of endogenous metabolic fluorescence and non-linear light scattering from structural proteins such as collagen. The application of Fluorescence Lifetime Imaging Microscopy with phasor analysis (Phasor-FLIM) reveals information about the concentration, distribution, and conformation of the metabolic co-factor Nicotinamide Adenine Dinucleotide (NADH) and flavoproteins, which are similarly involved in cellular metabolism. To evaluate non-invasive optical monitoring for the diagnosis of neoplastic disease, we have conducted a longitudinal study tracking changes induced by chronic UVA exposure of SKH-1 mice. While results clearly demonstrate changes in both metabolic co-factors and collagen localization, we seek to determine whether this approach could lead to earlier identification of skin cancer compared to a standard biopsy. Potential experimental strategies will be discussed.

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COMPACT STRUCTURAL DYNAMICS IN CELLULAR PRION PROTEIN CORRELATES WITH LOW SUSCEPTIBILITY TO MISFOLDING

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Prion diseases, featured by the autocatalytic misfolding of the cellular form of the prion protein, PrPC, to the infectious form, PrPSc, are fatal neurodegenerative disorders in mammals, including humans. Although PrPC from a number of mammal species share similar overall tertiary structure, compelling evidence indicates that not all species are susceptible to developing prion diseases. How the intrinsic structural dynamics of PrPC is affected by the specific primary sequence has not been thoroughly examined for prion proteins from species with either high resistance or high susceptibility to prion pathology. To fill this gap, we have implemented a structural bioinformatics protocol that tests the dynamics of PrPC using dynamic cross-correlation network analysis. Our analysis indicates that compact structural dynamics in cellular prion protein correlates with low susceptibility to misfolding. Intriguingly, our observations suggest that hydrogen bonds stabilize the PrPC structure that is prone to misfolding. The solvation profile of residues suggests that methionine is less exposed in PrPC, regardless of the misfolding propensity. We will interpret our analysis in light of possible routes of PrPC misfolding.

ANALYSIS OF A PUTATIVE FRAMESHIFTING RNA STRUCTURE FROM THE FUNGUS AGARICUS BISPORUS (MUSHROOM)

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Riboswitches are segments of non-coding RNAs that bind specifically to cellular metabolites and undergo a conformational change that results in a change in gene expression. Riboswitch regulatory

behavior in bacteria has been well documented in scientific literature but has remained relatively unexplored in eukaryotes. The crucial role of riboswitches in metabolism allows for the development of potential antibiological and antineoplastic agents. My project focuses on determining whether a predicted frameshifting element in the fungus Agaricus bisporus exhibits characteristics of a riboswitch. The results from a dual luciferase reporter assay (DLRA) indicate that the putative riboswitch exhibits a conformation change upon binding specifically with spermine and a change in gene expression in the presence of this metabolite.

A GENETICALLY ENCODED FLUORESCENT NITRIC OXIDE SENSOR

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Nitric oxide is an important signaling molecule in many biochemical pathways, and is consequently an attractive area of study for understanding cellular signaling. Fluorescent sensors are a particularly useful tool for imaging in vivo signaling processes, however, previously developed small-molecule nitric oxide sensors demonstrate a lack of selectivity and high background signals. A genetically encoded protein-based indicator would not have these limitations, as it could be targeted to specific cell types and organelles, and it would not need to be cell permeable. Herein, we demonstrate the incorporation of 4-aminophenylalanine into the tyrosine-66 position of green fluorescent protein (GFP). Incorporation at this position alters the structure of the GFP chromophore so that fluorescence is quenched in the presence nitric oxide. We have also synthesized 3-amino-4-methylaminophenylalanine, a novel unnatural amino acid that, when substituted for tyrosine-66, will demonstrate turn-on fluorescence in the presence of nitric oxide.

OVERVIEW OF AMERICAN YAK USING MITOCHONDRIA ALIGNMENTS

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Domestic yak, mainly distributed in the Qinghai-Tibetan Plateau, play important food, economic, and cultural roles in the Asian range (Basang et. al., 2017). In recent history, yaks have been imported to the United States and are growing in popularity. American Yak breeders are interested in understanding the lineage of their yak. From mitochondrial genome sequencing it has largely been determined that Domestic Yak in Asia fall into two distinct lineages (Lai et.al., 2006; Wang et.al., 2010; Guo et. al., 2006). From analyzing mitochondrial genomes of thirteen American Yaks, it appears that American yaks fall into two divergent lineages as well. Ten unique haplotypes were observed in the American yak population. A phylogenetic tree of the American Yaks, Tibetan yak, Tibetan cattle, and similar species show how the American population is related to similar groups. From analysis of aligned sequences, variances in mitochondrial genome were found. Some of the base pair changes have the possibility of being defining differences between American yaks and cattle.

MICROBIOME CHARACTERIZATION OF AN EXTREMOPHILIC POPULATION OF WETSALTS TIGER BEETLE, CICINDELIDIA HAEMORRHAGICA FOUND IN YELLOWSTONE NATIONAL PARK

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Yellowstone encompasses approximately 3,471 square miles, covers portions of three states, and contains a wide array of different geographical features. These geographical features include volcanic soils, bubbling mudpots, and spewing geysers. However, one of the most studied geographical

areas of Yellowstone is its thermal pools. Within these thermal regions, an extensive range of unique thermophilic life forms reside. The diverse thermophilic population includes indiscernible creatures such as miniscule bacteria to observable insects such as beetles. One population of beetle, Cicindelidia haemorrhagica or the Wetsalts Tiger Beetle, is subjected to the extreme conditions (such as pH, temperature, and acidity) of Yellowstone's thermal pools in which most organisms would not be able to survive or thrive. It is hypothesized that these beetles may be better adapted to this environment due to a unique microflora or microbiome population. Microbes have been reported to have the potential to provide beneficial services to its host but the classification of microbial genera has not been fully described for this species of beetle. Our primary focus of present has been to determine the most effective method of microbiota extraction and DNA purification from within the Wetsalts Tiger Beetle microflora. The purpose is to eventually characterize the bacterial microflora genera in two populations of beetle, one that is a known thermophile found in Yellowstone and the other in a non-extreme environment. We will then be able to compare and correlate the presence of bacterial communities to the adaptation of survival in the extreme Yellowstone environment. Data to be presented. This project was funded by INBRE.

UTILIZING CHEMICAL MUTAGENESIS TO DETERMINE U21 MECHANISM OF ACTION IN TOXOPLASMA GONDII

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The intracellular parasite, Toxoplasma gondii (T. gondii) is the causative agent of toxoplasmosis and infects up to one third of the world's population with some regions experiencing much higher infection rates. Although asymptomatic in patients with intact immune systems, those with weakened ones (such as cancer and AIDs patients) can experience a multitude of ocular, pulmonary, and central nervous system diseases. Pregnant hosts can also transmit the parasite to the unborn fetus. Drug treatments for T. gondii are currently limited, with the standard being pyrimethamine, a dihydrofolate reductase inhibitor. Dihydrofolate reductase is an important enzyme in nucleotide synthesis but due to the similarity between the parasite's enzyme to that of the human, pyrimethamine exhibits toxic side effects such as nausea, repeated vomiting, and nervous system damage at high doses. Our lab investigates an experimental compound, U21, which has shown a 100% survival rate in mouse models. We are now investigating its mode of action. Many drugs function by binding to specific protein targets and rendering them useless. Since the DNA is directly responsible for the synthesis of proteins, we can modify the DNA to ultimately change the protein being produced. If the modified protein is the target of the drug, the mutated parasite will survive high doses of drug treatment, therefore inducing drug resistance. This process, chemical mutagenesis, has been utilized in our lab to introduce resistance in parasites hopefully containing a mutation in U21's drug binding site. The most resistant populations we have observed are 1.76x, 1.67x, and 1.58x compared to the wild type IC50. Whole genome sequencing will be done to identify single mutations shared between the resistant clones and compare them to the wild type parasite.

DECREASED TRICARBOXYLIC ACID (TCA) CYCLE IN STAPHYLOCOCCUS AUREUS INCREASES SURVIVAL TO INNATE IMMUNITY

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Staphylococcus aureus is a gram-positive bacterium responsible for 3 million cases of infection in the United States every year. A major concern with S. aureus is the possibility of recurring infections or relapse. One reason for this is the presence of persister cells - a dormant type of cell that exhibit

high tolerance for antibiotics. Recent studies have shown a connection between low intracellular ATP and persister cell formation. Specifically, this decrease in ATP, and therefore the increase in persister cell formation, comes from an interrupted tricarboxylic acid (TCA) cycle. Previous studies have also shown an increase in bacterial survival within a macrophage when the TCA cycle gene, fumC, was knocked out. These data led us to hypothesize the fumC knockout is better suited for survival within the macrophage. Specifically, we are testing growth in the presence of different concentrations and combinations of reactive oxygen species (ROS), reactive nitrogen species (RNS), and decreased pH. Preliminary results suggest the fumC knockout has increased growth in the presence of all three stressors, however no difference was observed in the presence of any one single factor alone. These findings may suggest persisters are better able to tolerate components of the innate immune system.

ROLE OF THE LRGAB OPERON IN PYRUVATE UTILIZATION IN STAPHYLOCOCCUS AUREUS

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Staphylococcus aureus is a gram-positive coccus-shaped bacterium that has been named a high-consequence “ESKAPE” pathogen by the CDC, which are notorious for their resistance to multiple antibiotics. In addition, the ability to form a biofilm makes some infections caused by this organism virtually untreatable. These biofilms are formed when a subpopulation of the bacteria sacrifices themselves, releasing their contents, including genomic DNA that becomes an important part of the biofilm matrix. Interest in the control of cell death and lysis has led to the identification of the S. aureus lytSR and lrgAB operons. Evidence suggests that lytSR encodes a two-component system that activates lrgAB transcription and that these together make up a part of a programmed cell death (PCD) pathway. Recent studies indicate the lrgAB operon is important for pyruvate utilization, potentially serving as a transporter for this metabolite. To examine this in greater detail, S. aureus strains were created to test if S. aureus growth with pyruvate as the main carbon source was impacted by the deletion of lrgAB. Results demonstrate that the lrgAB mutant has a growth defect under microaerobic conditions with pyruvate serving as the primary carbon source. In addition, measurements of pyruvate levels within the growth medium demonstrated that pyruvate was not consumed by the lrgAB mutant. The results of this study support a model in which lrgAB functions as a pyruvate transporter.

UTILIZATION OF FLUORESCENCE IN SITU HYBRIDIZATION TO IDENTIFY TARDIGRADE MICROBIOME

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The tardigrade, or water bear, is a microscopic organism that can withstand a range of environments. The resilience of these organisms is an area of study in regards to human health and how to utilize their protective abilities in our own treatments and therapies. One area of tardigrade biology that is still fairly elusive has been the characterization of normal microflora of these microscopic animals. The Human Microbiome Project has provided crucial information to the human microbiota community and its beneficial role in maintaining a healthy state. Thus, we want to discover the composition of the tardigrade microbiome, if at all. Due to the tardigrades being microscopic, our primary focus has been to isolate and amplify the microbial DNA of the tardigrade’s microbes. The initial values of isolated DNA were substantiated via a Qubit fluorometer and all values were too low for genomic sequencing. This led to our secondary focus of using other techniques to identify common bacteria found within tardigrades. This focus utilizes fluorescence in situ hybridization to identify specific genera of bacteria based upon commercially available probes. Data to be presented. This project was funded by INBRE.

DEVELOPMENT OF A SYNTHETIC BIOLOGY TOOLBOX FOR THE STUDY OF ROOT-MICROBE INTERACTIONS IN KITAAKE RICE

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The health and development of a plant system is greatly affected by the rhizobiome that is surrounding its root system (Berendsen, Pieterse, and Peter A H 2012). These two systems have created a symbiosis that is controlled in part by strigolactones that is secreted by the plant. This research focused on developing a better understanding on how increasing the biosynthesis of strigolactones (SLs) affects the symbiosis of the plant system and the rhizobiome. Root-specific genes from maize, Zea mays (Cutler 1953), and rice, Oryza sativa L. (Goff 2002), that help synthesis SLs were identified, isolated and domesticated into a vector for the Goldenbraid system (GB2.0) and then inserted into rice. This transformation of rice is then able to demonstrate how a rhizobiome is formed from the secretion of SLs and how the rhizobiome is forming a symbiosis with the plant in a monocot system. I was able to transform several kitaake rice seeds with domesticated genes from the Golden Braid (GB2.0) system as evidence shown on growth on a selected media. Further study will go into their root expression into soil with the transformed genes.

OPTIMIZATION OF A PCR-RFLP BASED SYSTEM OF GENOTYPING OF ACROPORA CERVICORNIS

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In this study, we report efforts to elucidate genetic diversity in populations of Acropora cervicornis (staghorn coral) located in the Bay Islands, Roatan, Honduras. Our methodology employs DNA extraction from hard coral branches and amplification of the Cytochrome c oxidase subunit I (CO1) by the polymerase chain reaction (PCR). Amplified PCR products were cycle sequenced and suitable restriction enzyme digestion sites for RFLP analysis were identified. RFLP patterns were then used to identify the most suitable and genetically diverse coral “strains” to use for local species recovery efforts. Our approach allows workers collecting A. cervicornis for nursery growth and transplantation to be informed in their efforts at a minimal cost per sample.

B CELLS AND DENDRITIC CELLS RESPOND TO PEANUT: A COMPARISON OF 3-DAY AND 10-DAY INHALATION MOUSE MODELS

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The mechanism of how peanut (PN) initiates immune responses to elicit PN allergy is limited. PN is commonly found in household dust and we have shown that PN exposure via inhalation sensitizes mice. Little is known about how antigen presenting cells (APCs) function in response to airway exposure to PN. This study aimed to compare 3-day and 10-day mouse models to elucidate how various APCs respond initially (3-day) and within more developed immune responses (10-day) in order to better understand the immunologic mechanisms driving the development of PN-allergic responses. To study APCs, lungs and lung draining lymph nodes (dLN) were collected from BALB/c mice after exposure to PN flour by inhalation three times during a 3-day (days 0, 1, 2) or 10-day (days 0, 4, 7) period. Single cell suspensions were stained with antibodies to identify APCs (macrophages, dendritic cells, and B cells) responsive to PN by flow cytometry. In both models, B cells, CD11c+ DCs, and CD103+ DCs responded to PN exposure. Most interestingly, we observed B cells and CD103+ DCs that display co-

expression of ST2 (receptor for IL-33) and IL-1R1 (receptor for IL-1a/IL-1b), to be reduced in mice exposed to PN. This data suggests B cells and DCs respond to PN via ST2 and IL-1R1-dependent mechanisms and that following exposure to IL-33 and IL-1a/IL-1b (we previously showed that these cytokines are produced by lung epithelial cells following PN inhalation), they downregulate receptor expression. Overall, this study provides a new understanding into how B cells and DCs respond to PN exposure in the airways, thus providing new mechanistic insight into the development of PN-mediated immune responses.

THE EFFECT OF SELECTIVE CARBON NUTRIENTS ON THE IN VITRO GROWTH OF GROWTH PLATE CARTILAGE

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Growth plate cartilage occurs in the human body as endochondral cartilage and is formed from a template of embryonic hyaline cartilage, which acts as a template for bone growth. The zonal architecture of a growth plate exists bidirectionally, and the growth of the growth plate is impacted by cell signaling, cell communication, oxygen concentration, and metabolism. The understanding of how growth plate cartilage is impacted by nutrient conditions as well as oxygen concentration helps develop and lay the foundation for further growth plate cartilage research, which then can be extended further into regenerative medicine techniques. This study looked at the effect of different culturing conditions, all of which had at least one of the main carbon sources (glucose, pyruvate, glutamine, and/or proline) on the longitudinal and appositional growth of growth plates obtained from the cranial base of neonatal mice. Two different oxygen levels were also tested, states of normoxia (20% O2) and hypoxia (2% O2), to determine the effect of oxygen content on the growth of growth plate cartilage. Conclusions gathered from this study showed that glucose and glutamine were the two most important carbon sources when culturing growth plates and that there is a synergistic effect when the two are combined. It was also concluded that one may need to vary culture media depending on the oxygen environment.

INFLUENCE OF PARKIN W402A MUTATION IN MITOCHONDRIA WITHIN MICE: A MORPHOLOGICAL AND MORPHOMETRIC APPROACH

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Parkin is a protein involved in the PINK1/PARKIN pathway and along with PINK1, it plays an important role in damaged mitochondria degradation. These proteins have as the main end goal to ubiquitin tag the damaged mitochondria so they can be degraded via proteasome disintegration. Healthy mitochondria can differ from damaged ones by looking at the mitochondrial networks within a cell. These mitochondrial networks can look like pathways in which mitochondria align together, they can be either long or short and deteriorated depending on mitochondria's health. The short and unhealthy mitochondria will make the cell signal for the PINK1/PARKIN pathway to occur. In some cases, mutations in these proteins can happen and alter the degradation pathway. These alterations in the PINK1/PARKIN pathway have been linked with the etiology of Parkinson's Disease or Parkinson's Disease-Related-Symptoms. One of these mutations is ParkinW403A in which the mutation causes a change from tryptophan to alanine in the 403rd amino acid. Our hypothesis is that W403A could be a mutation causing overactivity of Parkin in the pathway. In order to test it, we used mice with the same mutation (W402A in mice) and induced damage to HeLa cells and their mitochondria to check the reaction of the Parkin W402A (mouse) and Parkin Wildtype when transfected into such HeLa cells.

Analysis was completed in a morphological approach by taking microscopic pictures of the cells and in a morphometric approach by running the photos in a data set program called "Mitograph" which measures the parameters of these mitochondrial networks to check for healthy or damaged mitochondria.
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THE CHARACTERIZATION OF CARNITINE PALMITOYLTRANSFERASE II DEFICIENCY IN DEVELOPMENT OF ZEBRAFISH

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Carnitine palmitoyltransferase 2 (CPT2) protein is involved in the process of beta oxidation of long chain fatty acids. Research suggests that astrocytes, the glial cells of the brain, rely on beta oxidation to support neural growth during development and for synaptic function in adulthood. Deficiencies in CPT2 protein expression is associated with a plethora of severe medical symptoms such as respiratory and liver failure, seizures, hypoglycemia, and potentially schizophrenia. The relationship between CPT2 dysfunction and neurodevelopmental and neurological disorders establishes a clear need to better understand the role of CPT2 and lipid metabolism in the brain. Our central hypothesis is that transesterification of palmitoylcarnitine to palmitoyl-CoA by CPT2 is necessary for proper neural developmental and synaptic function and that disruption of CPT2 function leads to abnormal nervous system cell differentiation, migration, synapse formation and synaptic function.

In collaboration with clinicians we are studying the genotypic and phenotypic profile of a male proband with confirmed CPT2 deficiency as compared to his heterozygous parents and unaffected fraternal twin. In our research, we are also developing a zebrafish model system to investigate the mechanisms by which CPT2 mutation affects overall brain development and synaptic communication. Using a splice blocking morpholino construct, we have confirmed Cpt2 gene knockdown using PCR, and are currently in the process of confirming knockdown using Western Blotting for a translation blocking morpholino construct. We have characterized the phenotype of CPT2 deficient zebrafish. Significant differences in body length, tail length, tail curve, head shape, pigmentation, cartilage formation, blood vasculature, and swim bladder morphology are present in mutant fish compared to control morpholino and wild type fish. Oil red immunohistochemistry and lipid analyses using LC-MS/MS demonstrate significant differences in total acylcarnitine levels in mutant fish compared to control and wild type fish. Future aims are to perform morpholino CPT2 rescue experiments and to assess brain development both globally and regionally. Functional analyses will include electrophysiological and behavioral assessment of mutant and control zebrafish. Structural and functional abnormalities may contribute to the development of seizure and neural network deficiencies potentially underlying attention deficit disorders and schizophrenia. Results from these experiments will provide insight into how genetic deficiency in CPT2 and long chain fatty acid metabolic signaling influences brain development and function.

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NANOPORE SEQUENCING OF MITOCHONDRIAL DNA FROM SAMPLES OF THE INVASIVE JAPANESE BEETLE *POPILLIA JAPONICA*

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Popillia japonica has become established as a major urban pest species in Nebraska. In order to address questions such as the origin of Nebraska populations, and whether multiple colonization events have occurred, we have initiated DNA sequence studies from samples collected in Omaha. Multiple DNA extraction techniques were compared to optimize both yield and purity of the DNA. We are using Oxford Nanopore MinION DNA sequencers to obtain whole genome sequence data, and are computationally selecting mitochondrial DNA reads by mapping to the reference *P. japonica* mitochondrial genome (RefSeq NC_038115.1). DNA extraction and sequencing in a secondary school context is feasible using the MinION technology, opening up genomics as an education resource for high school students.

ENZYMATIC CHARACTERIZATION AND SITE-DIRECTED MUTAGENESIS OF A KEY HEME SYNTHESIS ENZYME - 5-AMINOLAEVULINIC ACID DEHYDRATASE FROM ESCHERICHIA COLI

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The tetrapyrrole biosynthetic pathway produces important biological products such as hemes, chlorophylls, siroheme, and cobalamin. After the initial production of 5-aminolaevuilinic acid (ALA) in the first step of the pathway, two ALA molecules are combined together by 5-aminolaevulinic acid dehydratase (ALAD) to produce porphobilinogen, the foundational structural piece used to create the basic tetrapyrrole structure characteristic of the hemes and chlorophylls. Notably, much is still not understood about the enzymes that construct this pathway, including ALAD, which is responsible for several life threatening and poorly understood disorders. The purpose of this study was to further characterize the activity of ALAD from E. coli with respect to its associated cofactors and attempt to conduct site-directed mutagenesis on the enzyme.

MEASURING GRANULOCYTE ACTIVITY TO UNDERSTAND THE POSSIBLE MECHANISM OF ACTION OF AN ANTISCHISTOSOMAL COMPOUND

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Schistosomiasis is a helminthic disease that affects more than 250 million people in endemic areas, as well as returning travelers. Schistosomiasis is the second leading cause of infectious disease morbidity only after malaria. Currently, the only available treatment for schistosome parasites is the drug praziquantel, which is only effective against the adult stage of the worm and not the juvenile. Due to increasing resistance to praziquantel and its limited effectiveness, it is crucial that other possible drug candidates be investigated. Fortunately, a new compound, EE1, with antischistosomal activity has proven effectiveness against both juvenile and adult worms in murine models of infection. The mechanism of this compound is unknown. We have applied techniques to provide insight into this anti-helminth activity, including electron microscopy, ELISA, and in vitro assays. Due to preliminary results, our work suggests the compound may function by inducing the host immune response.

EXPLORING ANTI-SCHISTOSOMA ANALOG SA91

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Schistosomiasis is a waterborne parasitic infection caused by 6 species within the trematode clade, with *S. mansoni, S. haematobium*, and *S. japanicum* being the most significant agents. This disease affects more than 250 million people worldwide. It is widespread in tropical as well as subtropical regions with higher distribution in areas lacking sufficient sanitation and safe drinking water. Although some possible alternatives are emerging, currently, the most effective drug treatment is praziquantel. The need for additional novel drugs is increasing as reduced efficacy has been noted, suggesting PZQ resistance. A derivative of aryl hydantoin Ro 13-3978, SA91, has been hypothesized to to target eosinophils, which are white blood cells that are increased in innate immune system responses post parasitic worm infections. Preliminary studies have indicated no impact of Ro 13-3978 on *S. mansoni in vitro* but activation of mouse eosinophil cells *in vivo* that attack the parasitic worms. With a potentially greater potency of SA91, this compound may have broader applications in the future as it enhances the innate immune system's natural response to parasites and other diseases.

NOVEL UNIVERSAL INFLUENZA B VIRUS VACCINE IMMUNOGENS FOR USE AS UNIVERSAL VACCINES

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On average approximately 37,000 people in the U.S. die each year due to seasonal influenza outbreaks. The Centers for Disease Control (CDC) struggles to predict the upcoming influenza viruses resulting in an ineffective influenza vaccine. The 2019 – 2020 influenza vaccine provides an example of vaccine mismatch where the vaccine poorly matches the circulating influenza strains. We have created Influenza B Epigraph hemagglutinin (HA) immunogens that are computationally designed to select the greatest coverage of B and T cell epitopes in the natural population. Our preliminary data shows Epigraph immunogens induce superior cross-reactive antibody responses, overall T cell immunity, breadth of T cell epitopes, and protection against influenza virus. The primary goal of this study is to clone the influenza B Epigraph HA immunogens into DNA and Adenoviral mammalian expression systems. We will characterize these novel HA immunogens for the prevention of influenza B virus infections. Ultimately, we seek to develop novel universal influenza vaccines that provide a foundation of immunity which protects against all past, present, and future influenza viruses.

CRYSTALLIZATION AND STRUCTURAL STUDIES OF PCNA-CAC1 FUSION COMPLEXES

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Replication-coupled nucleosome assembly is a biochemically relevant pathway that relates DNA synthesis and storage. The interaction between proliferating cell nuclear antigen (PCNA) and chromatin assembly factor 1 (CAF-1) is crucial to this pathway and mediates normal gene silencing and continued cell viability. Disruption of this interaction compromises genetic stability and genomic integrity. The only recognized interaction between PCNA and CAF-1 occurs via a PCNA interacting peptide(PIP) motif. Two distinctive PIP motifs have been identified in the human homolog of CAF-1, but only one has been identified in yeast CAF-1. My project utilizes X-ray crystallography to determine the structural

mechanism of binding between PCNA and CAF-1 by solving the three-dimensional structure of PCNA-Cac1 fusion complexes. Solving the crystal structure of PCNA-Cac1 will reveal the atomic details of this interaction, clarifying how and where binding occurs. This will contribute to our fundamental understanding of cellular replication and gene expression .

STRUCTURAL ANALYSIS OF OAZ RNA IN CRASSOSTREA GIGAS

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Riboswitches are segments of non-coding RNAs that bind cellular metabolites in order to modify expression of a downstream gene. Specifically, a riboswitch interacts with a precise ligand resulting in a conformational change in the RNA. This structural change can affect transcription, translation or RNA processing of a downstream gene, responsible for synthesizing more of the metabolite, thereby affording an elegant feedback mechanism of inhibition. Although riboswitches are widespread among bacteria, only one class further resides in fungi and plants. The Soukup lab is investigating a potential mammalian riboswitch (OAZ RNA) that is involved in polyamine biosynthesis. Polyamines are essential for cell growth and differentiation, and play a role in replication, transcription, and translation. The ability of riboswitches to control essential metabolic pathways has opened up the possibility that novel antibiological agents could eventually be synthesized that target riboswitches. The OAZ RNA is highly conserved across a variety of organisms. Previous work in the Soukup lab has found strong evidence for the presence of a riboswitch in the mouse OAZ1 RNA by studying riboswitch-ligand conformational changes and binding affinity for various polyamines. The goal of my research is to conduct similar tests to investigate the OAZ RNA from oyster, Crassostrea gigas. Specifically, preliminary results using in-line probing (ILP) and equilibrium dialysis indicate that the oyster OAZ RNA undergoes conformational changes in the presence of the polyamine spermine. Further experiments using isothermal titration calorimetry will aid in examining conformational changes, binding affinity and ligand specificity for this putative riboswitch.

STRUCTURAL ANALYSIS OF HUMAN OAZ1-PK RNA

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Riboswitches are segments of noncoding RNA that bind to products of cellular metabolism in order to regulate the expression of downstream genes. Upon binding to a metabolite, many riboswitches undergo a conformational change that modulates the expression of genes involved in the synthesis of the cognate metabolite, thereby providing a mechanism of feedback regulation for a particular biosynthetic pathway. This form of genetic regulation has been widely studied in bacteria, but no riboswitches have been identified in animals. The Soukup lab is investigating a potential riboswitch involved in the biosynthesis of polyamines, small organic molecules that play a role in cell growth and differentiation and are frequently upregulated in cancer cells. Polyamine synthesis is dependent on the ornithine decarboxylase enzyme (ODC), which is negatively regulated by ornithine decarboxylase antizyme (OAZ). The expression of antizyme protein is regulated by polyamine-enhanced translational frameshifting of the OAZ mRNA. Specifically, a pseudoknot (PK) in the mammalian OAZ RNA may play a role in this frameshifting. Previous work in the lab strongly suggests the presence of a riboswitch in the mouse OAZ RNA by demonstrating specificity of polyamine binding as well as polyamine-induced conformational changes. In order to determine the presence of a riboswitch in humans, equilibrium dialysis techniques were used to examine the specificity of polyamine binding to human OAZ-PK RNA. Preliminary data suggests specific binding of the polyamine spermine. Future studies will use in-line probing techniques to investigate polyamine-induced conformational changes. The ability to

target riboswitches and regulate metabolic pathways, such as polyamine synthesis, could lead to the development of novel antibiological and anticancer therapeutics.

ESCAPE FROM ADAPTIVE CONFLICT IN HUMAN A-AMYLASE GENES

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Adaptive conflict is a genetic mechanism that prevents evolutionary events that would disrupt or replace ancestral functions with novel functions. One way to resolve this conflict is through the Escape from Adaptive Conflict (EAC) model, in which a gene duplicates to create two identical copies of itself. The new copied gene can mutate to gain new functions even if the original function is disrupted because the original gene still functions normally. During primate evolution, two gene duplication events in the α-amylase gene family resulted in a few distinct genes that have either pancreatic or salivary expression. Salivary amylase (AMY1) would benefit from acidic stability in order to survive the stomach acid, and pancreatic amylase (AMY2A) would benefit from basic stability in order to survive the pancreatic bile. If each of these mutations occurred on the same gene, they would compromise one another. We aim to test whether pancreatic amylase (AMY2A) and salivary amylase (AMY1) have different levels of enzyme stability in basic solution. We hypothesize that AMY1 will have a lower basic stability than AMY2A, suggesting that the evolution of human α-amylase is an example of the EAC model. To test this, we will perform multiple assays on purified human α-amylase at pH levels ranging from an acidic environment of 4 pH to a basic environment of 10 pH. These assays will test the stability of both AMY1 and AMY2A proteins in basic and acidic environments. If our research shows a lower level of basic stability and a higher level of acidic stability in AMY1 compared to AMY2A my hypothesis will be supported. We can then present empirical evidence that the evolution of human α-amylase is driven by the EAC process. Alternatively, if our research shows that AMY1 has basic stability comparable to AMY2A, there is evidence that the AMY1 gene evolved to gain acidic stability without adaptive conflict.

PERSISTER FORMATION IN CLINICAL ISOLATES OF STAPHYLOCOCCUS EPIDERMIDIS

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Staphylococcus epidermidis is the leading cause of nosocomial infections in the United States. It is an opportunistic pathogen that is part of the normal skin flora and causes serious, reoccurring infections in immunocompromised patients. Persister cells are thought to be the cause of these reoccurring infections due to their ability to enter a dormant state and survive in the presence of antibiotics. Staphylococci are not unique in persister cell formation as persisters have been observed in other infectious microorganisms such as Candida albicans and Escherichia coli. Recent studies with Staphylococcus aureus, a pathogen similar to S. epidermidis, found that the formation of persister cells depends on the cell being energy deficient through a dysfunctional tricarboxylic acid (TCA) cycle. While the mechanism of persister formation for gram positive organisms was recently uncovered, the clinical relevance of persisters remains uncertain. To investigate this further we set out to determine whether antibiotic tolerance, mediated by persisters, varied among clinical isolates. Clinical isolates were challenged with vancomycin and surviving bacteria were enumerated over the course of ninety-six hours. 41 clinical isolates were screened with 51.2% of isolates having a high persister phenotype. Currently, clinical isolates are being tested for extracellular acetate quantities to determine whether there is a correlation between high persister formation and decreased TCA cycle activity. Preliminary results indicate that clinical isolates exhibit differing levels of tolerance to vancomycin despite having similar susceptibilities, potentially resulting in the chronic and reoccurring infections.

INVESTIGATION OF GENE SILENCING PROTEINS USING SINGLE MOLECULE MICROSCOPY

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Following DNA replication, DNA is wound around histone proteins and condensed into chromatin, in a process called replication-coupled nucleosome assembly. This process of DNA packaging is essential for the storage and protection of DNA, and it is mediated by two key proteins: proliferating cell nuclear antigen (PCNA), a DNA sliding clamp protein that acts as a tether in the recruitment of proteins for DNA replication, and chromatin assembly factor-1 (CAF-1), a PCNA-interacting protein that recruits histones to the replication fork. The CAF-1-PCNA interaction is essential for gene silencing, but the process by which the proteins mediate gene expression is still unclear. We have carried out preliminary binding assays to identify novel interactions between these two proteins. We will also examine the kinetics of the interaction between CAF-1 and PCNA using total internal reflection fluorescence (TIRF) microscopy. Preliminary efforts have verified a recently built TIRF microscope at Creighton in addition to developing and establishing a protocol for TIRF using CAF-1 and PCNA proteins. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

CHEMISTRY AND PHYSICS

CHEMISTRY

ACETATE-ASSISTED SYNTHESIS OF CERIA NANOPARTICLES WITH OZONE

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Ozone-mediated synthetic routes present advantages in speed and size control to produce oxide nanomaterials. Our previous study successfully applied such an approach to synthesize ceria nanoparticles with a reaction yield of ca. 10%. Here we report our study of the effect of adding lithium acetate in this ozone-mediated synthesis to increase the reaction yield of crystalline ceria nanoparticles to over 90 % by cerium content. The effects of this methodology on the physical characteristics of the NPs were investigated. Through thorough characterization of the produced nanoparticles, the effect of increasing lithium acetate to cerium nitrate ratios was explored to demonstrate the relationships between product yield, acetate concentration, crystallinity, and size distribution of nanoparticles.

UTILIZING ALGINATE TO INCREASE THE BUFFERING CAPACITY OF SODIUM BICARBONATE TOOTHPASTE

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In this study, the buffering capacity of toothpaste will be compared between test groups to see which medium is best for maintaining a neutral pH for the greatest time. Sodium bicarbonate is one of the main focuses of this study. Sodium Bicarbonate is cheap, safe, antimicrobial, has low abrasiveness, and works well as an oral pH buffer; all of which make sodium bicarbonate a practical choice for use as an oral dentifrice. The second medium of interest is alginate. Derived from brown microalgae, alginate has been used as a safe temporary bonding agent in surgical procedures and could prove useful in increasing the buffering time of sodium bicarbonate. The hypothesis of this study is that sodium bicarbonate combined with alginate can temporarily bond to teeth and prolong the localized buffering effect past that of sodium bicarbonate-containing toothpaste to reduce risk of enamel demineralization.

Bovine teeth were chosen for this experiment because of the close resemblance to human teeth in both chemical composition and physical characteristics. Bovine teeth were harvested from detached mandibles, cleaned with an antibacterial, and stored in artificial saliva solution. A control toothpaste containing 0.24% fluoride was applied to 10 teeth with an electric toothbrush (brushed for 15s each) and rinsed with distilled water. Dilute hydrochloric acid was then added to the artificial saliva containing the brushed tooth to represent an acid challenge. pH changes were monitored past the point of neutralization to see if pH would return to acidic conditions. The above methods were repeated with a 0.24% fluoride + sodium bicarbonate toothpaste (test group 1), followed by a sodium bicarbonate toothpaste + alginate mixture (test group 2). Research is ongoing and results will be updated, followed by a conclusion and any additional information found in the future. At this time the hypothesis has not been rejected.

NANOPARTICLE PALLADIUM HYDROGENATION CATALYSIS OF ALKYNES. THE VINYL REVERSAL AND HORIUTI-POLANYI MECHANISMS

Kenzie Enmeier*, Kara Grossman, Grace Recker*, Katie Cunningham, Grayson Huldin, Giorgio Bacchin, Lydia Johnson, Samaya Kallepalli, Laura Cogua and Bruce Mattson, Department of Chemistry, Creighton University, Omaha, NE 68178

Alkynes are hydrogenated to alkenes and alkanes in the presence of Al-supported nanoparticle palladium catalyst (0.5%). Studies involving the hydrogenation and deuteration of 1-butyne are presented in the context of the accepted mechanisms for these reactions. Specifically, we will address these questions: Do alkynes or alkenes react faster or preferentially with hydrogen? Can we pass a 1-butyne-H2 mixture fast enough so that the catalyst is overwhelmed and not all hydrogen reacts? How does the amount of hydrogen used affect product distribution? How extensive is D/H exchange when 1-butyne is reacted with D2? Can deuterium atoms from one alkene end up on a different D-free alkene? Can we observe alkyne hydrogenation without Horiuti-Polanyi D/H exchange? Is there evidence for dissociation of 1-butyne from palladium?

ADJACENT PA01 BIOFILM COVERAGE USING FLUORESCENCE MICROSCOPY

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Biofilms are groups of microorganisms that grow together on various surfaces such as medical equipment, metals, and human teeth. Given their community nature, biofilms have a unique ability to adapt and be more resilient to stress caused by a change in pH; or the addition of antibiotics. Biofilm growth can lead to a variety of health problems such as bacterial infections and are a particular area of concern for patients with implanted medical devices. The purpose of this study is to examine how the coverage of PA01 over a glass surface is impacted by the presence of an adjacent modified layer. The biofilm coverage will be quantified using a combination of fluorescence microscopy and crystal violet assay techniques. The focus for this project going forward is to finish collecting any remaining data using the same developed fluorescent method to quantify PA01 coverage across a glass surface adjacent to new modified layers ranging in hydrophobicity and structure.

SYNTHESES OF HOMOALLYLIC ALLENE-CONTAINING ALCOHOLS BY SEQUENTIAL HYDRIDE REDUCTIONS

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Homoallylic alcohols are useful in organic synthesis and are important natural products: These include sterols (cholesterol, campesterol, ergosterol) xanthophylls (lutein, zeaxanthin, cryptoxanthin), sesquiterpenoids (ivalin, dictyolene, pacifigorgiol) and marine metabolites with anticancer potential (calyculin). We previously determined that sequential 1,2-, 1,4-hydride addition of hydridoaluminates

to 3-alkynyl-2-cycloalkenones provides stereoselective access to allene-containing homoallylic cycloalkanols. The reaction extends to a range of other homoallylic alcohols: Double hydride additions of various 3,5-alkadien-2-ones result in mixtures of 3-alkenols and 4-alkenols favoring the homoallylic products; 3-alken-5-yn-2-ones provide homoallylic 4,5-alkadien-2-ols; conjugated 5-alken-3-yn-2-ones result in 3,5-alkadien-2-ols only, and 3,5-alkadiyn-2-ones provide 3-alken-5-yn-2-ols.

ANALYSIS OF DRUG-PROTEIN INTERACTIONS USING ULTRAFAST AFFINITY EXTRACTION

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The quantitation of free drug fractions is important because this fraction is responsible for the overall pharmacological activity and toxicity of drugs inside our body. In this project, ultrafast affinity extraction has been employed to study the equilibrium and kinetic processes that take place during the interactions of various pharmaceutical agents (e.g., warfarin, gliclazide, glipizide and glibenclamide) with human serum albumin (HSA), the most abundant transport protein in the blood. HSA was covalently immobilized onto the diol bonded silica and placed into affinity microcolumns. These microcolumns were then used to extract the free fractions of drugs from drug-HSA mixtures in solution. Various experimental conditions, such as the flow rate and column size, were optimized for these free fraction measurements. The association equilibrium constants measured for the tested drugs were in the range of 104 to 106 M-1 s-1, and the corresponding dissociation rate constants were in the range of 0.5 to 2.2 s-1. The measured equilibrium and rate constants showed good agreement with literature values. Advantages of this method were its ability to use small sample injection volumes (5-20 μL), its rapid analysis times (typically 1-10 min), and its ability to directly examine solution-phase interactions. The information obtained from this method can be useful in understanding how these drugs interact with HSA when they are circulated in blood.

PROBING WEAK INTERACTIONS: STEREO- AND REGIOSELECTIVITY IN CAVITAND-MEDIATED 2+2 PHOTOCYCLOADDITION REACTION

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The 2+2 photocycloaddition (PCA) reaction is an efficiently, which is often precluded by photoisomerization reaction. Our group has demonstrated the utility of cavitands, macromolecules with defined molecular binding sites (cavities), in improving PCA of a variety of disubstituted ethylenes. Regio- and stereoselectivity of cycloadducts in cavitand-mediated reactions is influenced by attractive and repulsive interactions between supramolecular moieties in the reactants. Thus, it is reasoned that retrospective analysis of selectivity observed in cavitand-mediated PCA could be used as a probe magnitude and directionality of weak interactions. This approach has been used to manifest weak forces such as pi-pi, halogen-halogen, and hydrophobic interactions.

INHIBITION OF FOSB, AN EMZYME PRODUCED BY METHICILIN-RESISTANT STAPHYLOCOCCUS AREUS (MRSA)

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Antibiotic resistant bacterial infections are a growing issue. Antibiotic drugs are quickly becoming obsolete. There has not been a proportional production of new antibiotic drugs to compensate for the decline in effective medications. Since 1960, only four new classes of antibiotics have been introduced, three of which are still in clinical trials. Fosfomycin is a broad-spectrum antibiotic which

can be used to treat gram-negative and gram-positive bacterial infections. Fosfomycin enters the cell through nutrient transporters and inhibits peptidoglycan synthesis causing cell death. Fosfomycin is commonly used to treat urinary tract infections. Methicillin-resistant Staphylococcus aureus (MRSA), and other gram-positive bacteria, are naturally resistant to Fosfomycin. MRSA naturally produces the FosB enzyme, which provides resistance to Fosfomycin. Inhibition of the FosB enzyme would make MRSA susceptible to treatment with Fosfomycin when given in combination with the FosB inhibitor. FosB inactivates Fosfomycin by catalyzing the nucleophilic attack of bacillithiol (BSH) to carbon 1 of the antibiotic, opening the epoxide ring and rendering the drug ineffective. FosB is a rigid enzyme, limiting the possible molecules which could bind to the active site and act as inhibitors. The purpose of this research was to determine if N-acetylglucoseamine-malate (GlcNAc-Mal) will inhibit the activity of FosB. GlcNAc-Mal is an intermediate in the biosynthesis of bacillithiol and is similar in structure to bacillithiol, which indicates GlcNAc-Mal may competitively inhibit FosB activity. The activity of FosB will be analyzed at varying concentrations of substrate with and without the presence of GlcNAc-Mal. The products of the kinetic assays will be derivatized and analyzed using high-performance liquid chromatography (HPLC). Currently, a standard curve has been developed and analysis of kinetic assays are underway. The data collected during this research will provide a foundation for further research to develop antibiotic therapies for gram-positive antibiotic resistant infections.

DOCKING STUDIES OF THE INTERACTION OF TEIXOBACTIN ANALOGS WITH LIPID II-BOUND GLYCOSYLTRANSFERASE

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The relatively recent discovery of the antibiotic teixobactin has increased interest in its mechanism of action. Teixobactin binds to lipid II and lipid III, both of which are important components for cell wall synthesis. Docking studies were done on two lipid II-bound glycosyltransferase proteins, 3VMT and 6FTB (PDB ID), in order to find the amino acid residues that interact most with the proteins. Our Data show that residues Arg17, Ser124, Asp125, Arg126, and Lys248 of 3VMT, and Arg148 and Asn224 of 6FTB may be important for ligand binding.

SYNTHESIS OF FLUORESCENT PROBES FOR SELECTIVE HYDROGEN SULFIDE CONCENTRATIONS IN LIVING CELLS

Dr. Haishi Cao, Wuilian Martinez*, Department of Chemistry, University of Nebraska at Kearney, NE. 68849

Hydrogen Sulfide (H2S) is an endogenous molecule found inside of many living cells in the human body. Interest in the biomedical role of H2S has increased because, depending on the concentration of H2S, it may either act as a therapeutic antioxidant, or as a harmful toxin. To understand the role of H2S in living cells, real time detection of H2S concentration is necessary. Fluorescent probes made through a multi-step organic synthesis may serve as a means of detection for H2S concentrations. In this project, several derivatives of 1,8-naphthalimide have been synthesized and characterized. The absorption and emission spectra of these derivatives have been investigated as signals for quantitative detection of H2S.

ANALYSIS OF THE METABOLIC EFFECTS OF DIABETES ON THE FUNCTION AND STRUCTURE OF GLYOXAL AND METHYLGLYOXAL-MODIFIED HUMAN SERUM ALBUMIN

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During diabetes, human serum albumin (HSA) is modified by reactive dicarbonyl compounds such as methylglyoxal (MGO) and glyoxal (GO). These compounds react with the lysine and arginine residues on HSA (an important drug-carrying agent) to form advanced glycation end-products (AGEs), which have been implicated in diabetes and its complications. This study characterized the metabolic effects of diabetes on the structure and function of HSA. High-performance affinity chromatography (HPAC) was used to investigate the changes in a binding that occur with specific drugs with MGO and GO-modified HSA. Zonal elution studies were carried out with repaglinide (a drug used to treat type II diabetes) on columns that contained HSA or modified HSA prepared in vitro. R-Warfarin and L-tryptophan were used in these studies as site-selective probes for Sudlow sites I and II of HSA (the major drug-binding sites on this protein. The structural alterations in HSA caused by the different levels of MGO and GO were evaluated by using a high-resolution matrix-assisted laser desorption/ ionization Fourier-transform ion-cyclotron resonance mass spectrometer. The differences in the function and structure of HSA at different levels of MGO and GO modification for HSA were compared. This information should provide a better understanding of the metabolic effects of diabetes on drug binding with HSA and the effects of glycation-related changes on this protein, as can be used in the future to develop improved treatments for diabetes patients.

ELECTROPHILIC HALOCYCLIZATION REACTION IN AQUEOUS MEDIA: SUPRAMOLECULAR AND GREEN CHEMISTRY ASPECTS OF THE REACTION

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o-Alkoxy diaryl acetylenes undergo iodocyclization to yield substituted benzofurans in organic media with moderate reaction efficiency. We observed the of positive influence of macrocyclic cavitands, cyclodextrins and cucurbiturils, on reaction rate and conversion in aqueous media compared to organic solvents. This presented an excellent opportunity to understand mechanistic basis of the reaction and explore its green chemistry aspects. We furthered explored the electrophilic bromocyclization and even chlorocyclization reactions involving intramolecular oxygen nucleophiles, which are typically difficult to achieve, especially for oxygen nucleophiles. This talk will present our approach to achieving enhancement of reaction efficiency achieved through supramolecular control in an environmentally benign manner.

THE REMINERALIZING EFFECTS OF SODIUM FLUORIDE TOOTHPASTES ON THE ENAMEL OF BOVINE TEETH

Lydia Sigler*, Tim Keith, and Mary E. Keithly, Department of Chemistry, Chadron State College, Chadron, NE 69337

A problem that the majority of Americans face is tooth decay. The current treatment for tooth decay is drilling out the decay and then filling it with an amalgam or composite filling. Fluoride has been shown to reverse the effects of enamel decomposition. Teeth are composed of a hydroxyapatite-like structure. When exposed to an acidic environment created by oral bacteria, the hydroxyls present in the hydroxyapatite-like structure are removed. Fluoride treatments are used to fortify the teeth with fluoride ions in place of the missing hydroxyl groups, creating a new fluorapatite-like structure within the enamel. Fluorapatite is stronger and more stable than hydroxyapatite due to fluorides high

electronegativity. The purpose of this experiment was to test different sodium fluoride toothpastes and observe if they effectively remineralize teeth. Bovine teeth were used in this experiment due to their similar structure to human teeth. The teeth were kept in a saliva-like solution that provided the minerals necessary for the recrystallization process to occur. The controls were brushed with a training toothpaste that had no sodium fluoride. One experimental toothpaste had a 0.25% sodium fluoride concentration, and the other experimental toothpaste had a 1.1% sodium fluoride concentration. The experiment consisted of regularly brushing the teeth with the toothpastes and then storing them in the saliva-like solution. The tooth samples are currently being digested in a solution. Once in solution the fluoride concentration will be analyzed using a fluoride probe. At this time data is still being collected and analyzed.

IMPACT OF GOLD SURFACES ON THE ATTACHMENT AND PROLIFERATION OF PA01 BIOFILMS

Elijah D. Stowe*, Patrick Dussault, Department of Chemistry, University of Nebraska-Lincoln, NE, 68588

The Fenton reaction, discovered by Fenton in 1876, uses Fe(II) to reduce peroxides and generate reactive oxygen species. In the beginning these reactions were focused on the degradation of sugars by Fe(II) and hydrogen peroxide, but it has grown since then to encompass the Fe-based activation of a wide range of peroxide derivatives. The activation of hydrogen peroxide, alkyl hydroperoxides, ozonides, and other reactive oxygen species often occurs under mild conditions. The turnover of these species can be quite slow, however, and more sterically hindered peroxides can be inert to Fenton conditions. Here we report a new Fenton-type system using catalytic iron salts in the presence of stoichiometric borane to reduce peroxides. In our preliminary work several dialkyl peroxides have been rapidly reduced by 0.1 mole% Fe(II) in the presence of a stoichiometric source of B-H. These reactions occurred rapidly with a large turnover number, but they are much less exothermic than is expected based on theoretical calculations. Our presentation will describe the reactivity of the new system towards both peroxides and selected functional groups and will contrast the Fe/borane chemistry from a recently reported Fenton/Haber-Weiss catalyst derived from iron thiolates.

HEMP POTENCY TESTING WITH ULTRA-HIGH PERFORMANCE LIQUID CHROMATROGRAPHY (UHPLC)

Arin Sutlief* and Andrea Holmes, Department of Chemistry, Doane University, Crete, NE 68333

This year, for the first time in over 90 years, hemp is a legal crop in Nebraska potentially opening a new lucrative market for farmers. With the passing of the federal 2018 Farm Bill followed closely by the Nebraska Hemp Farming Act in 2019, hemp was newly defined as the plant Cannabis sativa L. with a Δ9-tetrahydrocannabinol (Δ9-THC) concentration less than 0.3% of dry mass and thus removed from the controlled substance act. To stay within state regulations, crops must be tested for Δ9-THC and tetrahydrocannabinolic acid (THCA) concentrations to analyze potency levels making sure they are within the legal limit. High performance liquid chromatography (HPLC) is becoming the accepted standard for state/federal lab potency testing and was used to evaluate hemp plants maintained in the Doane University greenhouse. This presentation will cover the sample prep and HPLC procedure for testing a variety of materials including plants, isolates, and consumer products and go over the interpretation of results.

EVALUATION OF THE OVERALL BINDING OF ACETOHEXAMIDE AND TOLBUTAMIDE WITH METHYL GLYOXAL-MODIFIED HSA BY HIGH PERFORMANCE AFFINITY CHROMATOGRAPHY

Ashley G. Woolfork*, Miranda Weigand, and David S. Hage, Department of Chemistry, University of Nebraska-Lincoln, NE 68588

High performance affinity chromatography (HPAC) was used in a zonal competition format to investigate the overall binding of two sulfonylurea drugs with modified human serum albumin (HSA). The in vitro modifications of this protein that were examined included glycation, as occurs in the presence of elevated glucose levels during diabetes, and the formation of advanced glycation end-products (AGEs) due to the reaction of HSA with methylglyoxal (MGo). The sulfonylurea drugs acetohexamide and tolbutamide, which are used to treat type II diabetes, were each injected onto 10 mm x 2.1 mm i.d. affinity microcolumns that contained normal HSA and HSA modified with MGo. Competition studies based on a zonal elution format were carried out by using R-warfarin as a site – specific probe for Sudlow site I of HSA and L-tryptophan as a site-specific probe for Sudlow site II. The studies were performed with eight mobile phase concentrations of the drugs, ranging from 0-25 μM, and at a flowrate of 0.5 mL/min and a temperature of 37°C. The resulting information made it possible to determine the site-specific association equilibrium constants for each drug with normal and modified HSA. A decrease of approximately 0.4-fold to 0.8-fold in binding strength was found when comparing normal HSA vs control MGo-modified HSA and normal HSA vs diabetic MGo-modified HSA. These experiments illustrated how affinity microcolumns and zonal competition could be used in detailed studies of interactions by sulfonylurea drugs with normal HSA and modified forms of this protein. Such information may be useful in future applications within the field of personalized medicine for the development of customized treatments for patients with type II diabetes.

CHEMISTRY AND PHYSICS

PHYSICS

IMPLEMENTING GLUCOSE-DERIVED CARBON NANODOTS IN NANOCRYSTALLINE INJECTION SOLAR CELLS TO INCREASE EFFICIENCY

Max Markson DiPrince, Creighton University, Omaha, NE.

Although carbon nanodot isolation remains difficult due to the presence of molecular byproducts in a bottom-up synthesis approach using thermal treatment of carbohydrate solutions, their resultant photoluminescence shows promise for down-converting UV photons. In particular, excitation at 390nm results in significant luminescence from 490–540nm, with an excitation wavelength dependence of luminescence (peak absorption occurs at 290nm). Carbonaceous nanodot solutions were derived from high-concentration glucose solutions at 120°C for a 48 hour period and then incorporated into Ruthenium-based dye-sensitized solar cell devices to enhance external quantum efficiency for high energy photons. We found that dialysis combined with solid phase extraction retained photoluminescent properties while allowing for carbon dot isolation in acetonitrile, a soaking solvent for dye-sensitization of TiO2 nanoparticles, with minimal measurable traces of other chemical byproducts. Successful purification processes, photoluminescence, external quantum efficiency, and J-V curves of these carbon dot-modified devices will be shown to verify this low-cost, earth abundant approach to efficiency enhancement of dye-sensitized solar cells.

MATHEMATICAL MODELLING OF IMPEDANCE-BASED CELL MIGRATION FOR PHYSICS OF CANCER

Melanie Schwengler1, Andrew Walther1, Michael Mimlitz1, Harry Kramer2, Jack Lewison2, Megha Jacob2, Joe Bamesberger3 and Dr Andrew Ekpenyong1; 1Department of Physics, Creighton University, Omaha, NE 68178, USA; 2Department of Biology, Creighton University, Omaha, NE 68178, USA; 3Department of Chemistry, Creighton University, Omaha, NE 68178, USA

Background: Physics of Cancer is a novel research frontier which seeks to unravel the role of physical interactions and mechanical forces in metastasis. Metastasis itself is the complex process by which cancer cells spread from the primary tumor to other tissues and organs of the body where they form new tumors. It leads to over 90% of all cancer deaths. An important step in the metastatic cascade is migration. Various chemotherapeutic and radiotherapeutic approaches target cancer cell proliferation and not metastasis. We have recently quantified extensively, the impact of these approaches on cancer cell migration, using bioimpedance as a readout. Here, we present mathematical models for our vast experimental data which provide mechanistic insights into the role of various chemotherapeutic and radiotherapeutic approaches on cancer metastasis.

Methods: Having recently used a commercially available Electric Cell Impedance Sensor (ECIS) to quantify the migration of various cancer cell lines following chemotherapy and following radiotherapy (using a cell irradiator, Faxitron), we applied equivalent circuits and power-law equations to model the complex impedance data, using MATLAB codes.

Results: Fits of equivalent circuit models and power-law models quantify and characterize the raw impedance data for neuronal cells, brain cancer cells and macrophages. Moreover, even without data fitting, we find that the irradiated HCN2 cells (neurons) and T98G cells (Glioblastoma, brain cancer cells) attach and migrate significantly more than non-irradiated cells in the first 20 hours post irradiation. Conclusions: The model parameters such as the power-law exponent capture the increased migration of irradiated cells prior to cell death, providing robust and biophysically relevant insights into metastasis which can potentially inform urgently needed anti-metastasis strategies in cancer treatments.

MICROFLUIDICS FOR THE PHYSICS OF CANCER USING SOFT LITHOGRAPHY

Chisom Nwakama, Ashley Abraham, Megha Jacob, Gargee Khaparde, Mackenzie McCuddin, Dr Andrew Ekpenyong; Creighton University, Omaha, NE

Purpose/Rationale: Soft lithography denotes techniques for fabricating or replicating structures using elastomeric stamps and molds. Microscopic structures within the body such as the pulmonary microcirculation and the microenvironment of cancer cells can be mimicked in vitro using microfluidics. Such mimicry is an important tool for the physics of cancer, a new research frontier that seeks to unravel the role of mechanical properties, forces and interactions on cancer metastasis with the aim of enabling new therapeutic strategies against metastasis. Here, we use soft lithography to make microfluidic devices for the physics of cancer.

Methods: Basically, we make a mixture of polydimethylsiloxane with a curing agent, poor it on to silicon molds made by photolithography, oven-bake it into a solid structure and bond glass cover slips under vacuum and air plasma. The device is called microfluidic microcirculation mimetic (MMM). The passage of cells driven through MMM should be correlated with the mechanical properties of the cells.

Results: MMMs with 5 and 7 μm as the smallest constriction widths (maximum width 15 μm)

are made with a constant height of 15 μm. The inlet and outlet of the devices are connected to a syringe pump and the setup is placed on an inverted microscope for experiments. We have successfully made hundreds of these devices for experiments.

Conclusions/Significance: The MMM is a physiologically relevant lab-on-chip device for mimicking various microscopic events going on in the body including the circulatory phase of cancer metastasis. This mimicry may enable the development of better diagnostic and therapeutic strategies against cancer metastasis.

DESIGN OF A BENCHTOP FLUIDIZED BED REACTOR FOR BIOFILM STUDIES

Madison R. Stevens, Shingirayi M. Kamucheka, Christopher D. Wentworth, and Joel R. TerMaat, Department of Physics and Engineering, Doane University, Crete, NE 68333

One of the most widely used herbicides, atrazine, attributes to a large majority of drinking water contamination, particularly in rural areas. Atrazine has been linked to preterm deliveries and fetal development complications for expecting mothers and heart, liver, and kidney damage in animals and humans. The use of bacterial biofilms is a promising approach for atrazine remediation. In this investigation, a compact fluidized bed reactor system was developed as a platform for biofilm treatment. Temperature measurement and control of the stainless steel reactor was implemented using a flexible pipe heater and direct fluid contact sensors coupled to a Raspberry Pi interface programmed in Python. The control performance of the designed system was evaluated at multiple temperature setpoints, and will facilitate further laboratory biofilm growth and process optimization studies. This biofilm-based reactor can be used to develop improved methods of removing atrazine pollutants from groundwater drinking sources.

SOFTWARE UPDATES FOR THE MAIN DETECTOR CONTROLS WEB PAGE AT THE STAR EXPERIMENT AT BROOKHAVEN NATIONAL LABORATORY

Emma Dufresne, Creighton University, Omaha, NE

STAR (Solenoidal Tracker at RHIC), the high-energy physics experiment at Brookhaven National Laboratory, analyzes collisions of heavy ions traveling at relativistic speeds using various detectors. For safety reasons, remote computers are programmed to retrieve data from these detectors. A controls system manages the various computers that allow STAR to function. STAR's control system uses EPICS (Experimental Physics and Industrial Control System), a set of software tools that enable communication between the detector and the computers. The largest part of the controls system involves the operation of power supplies and monitoring their voltage values. Detector operators can monitor safety information about the detectors from a single web page. Information about water and gas alarms, operating status of the sub-detectors, and environmental conditions can all be seen at a glance. The STAR detector controls framework is being gradually updated to include PC-based rather than embedded computers and to incorporate PyEpics, an interface allowing EPICS to interact with the Python Programming language. These changes allow easier maintenance and updates in the future. This specific project completely re-wrote, using PyEpics and HTML, the code that gathers information and fills the main detector controls web page to remove outdated values and eliminate the need for frequent rebooting. This new code was successfully implemented before the end of the 2019 run.

PRODUCTION OF ρ^0 MESONS IN ULTRA-PERIPHERAL D-AU COLLISIONS AT RHIC

Solon Fernandes, Creighton University, Omaha, NE

The Relativistic Large Hadron Collider (RHIC), located at the Brookhaven National Lab, Long

Island, accelerates and collides fully ionized gold nuclei at relativistic speeds. Many of the collisions at the RHIC are Ultra Peripheral Collisions, which depend on long range electromagnetic interactions between nuclei, rather than on the stronger nuclear force. The nuclei interact primarily by two-photon or photon-pomeron exchange. Virtual photons emitted by one nucleus can fluctuate into a quark anti-quark pair. I'm going to speak about the production of ρ^o meson during the deuteron-gold collisions.¬¬ The ρ^o meson can be produced in two ways – either a photon emitted by the gold nucleus interacts with the deuteron and produces a ρ^o, or a photon produced by the deuteron interacts with the gold nucleus to produce a ρ^o. I will discuss the relative probabilities of these two modes of production, and the procedure used to select and analyze these events.

INTEGRATION OF CONTROLLED EVAPORATION MIXING (CEM) LIQUID DETECTOR FOR STGC AT STAR EXPERIMENT

Rebecca Powers, Department of Physics, Creighton University, Omaha, NE, 68178

The Solenoidal Tracker (STAR) at Brookhaven National Laboratory is a large detector system built for the detection of quark gluon plasma formation at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. A crucial component of the STAR detector is the Forward Tracking System (FTS), which is responsible for measuring the charged track momenta of particles traveling out from a collision at RHIC. The STAR FTS requires exact amounts of various gas mixtures to operate at exact temperatures for optimal performance. A new small strip thin gas chamber (STGC) is being implemented at the STAR FTS, comprising of a gas mixture of 45% N-pentane and 55% carbon dioxide. N-pentane is a very flammable liquid, and so an excess in the mixture would significantly increase combustion hazards. Because of the chemical properties of the gaseous mixture, an excess of pentane in the mixture will cause it to condense and drip into a liquid detection system. This presentation specifically focuses on the implementation of new alarm (hardware and software) that responds to liquid in the detection system. The implementation of the new alarm system will prevent an excess of pentane operating in the mixture, which would prevent combustion hazards in the STAR FTS.

ρ' PHOTOPRODUCTION IN ULTRA- PERIPHERAL HEAVY ION COLLISIONS WITH THE ALICE DETECTOR

Gamamedaliyanage Ann Shani Perera, Creighton University, Omaha, NE

I am working with the ALICE (A Large Ion Collider Experiment) detector at the Large Hadron Collider (LHC) in Geneva. The LHC is the world's largest and most powerful particle accelerator. When heavy nuclei are directed at each other they can collide centrally, or they can miss each other. If the two nuclei miss each other (with an impact parameter greater than twice the lead-ion radius), it is called an Ultra-Peripheral Collision (UPC). Since there are no hadronic interactions in ultra-peripheral collisions, the nuclei do not interact via the nuclear force but rather the long-range electromagnetic force. These ultra-peripheral heavy ion collisions are used to study photonuclear effects as well as photon-photon interactions. In the ALICE detector, ultra-peripheral Pb-Pb collisions at $\sqrt{Snn}$ = 5.02 TeV can produce excited ρ mesons which decay into $\pi+ \pi- \pi+ \pi-$. I present the analysis procedure used to select these events and study the ρ'.

STARLIGHT: A MONTE CARLO SIMULATION PROGRAM FOR ULTRA-PERIPHERAL COLLISIONS MATTHEW ELLER

Matthew Eller, Creighton University, Omaha, NE

Ultra-peripheral collisions are interactions between two relativistic ions that interact through the exchange of virtual photons. The intensity of the electric field and therefore the number of photons

emitted from the nucleus is proportional to the square of the atomic number Z2.Two types of interactions in ultra-peripheral collisions are photon-photon and photonuclear. In photon-photon interactions, the photons emitted from each ion interact with each other. With photonuclear reactions, one radiated photon interacts with the nucleus of the other ion. With either type of collision, it is possible for the nuclei to remain intact or for one or both of the nuclei to break up.

STARlight is a Monte Carlo simulation that models the photon--photon and photonuclear interactions that arise in relativistic collisions between nuclei and protons. This program is used to generate a variety of final states.

I will present an overview of the physics of ultra-peripheral collisions, give an introduction to the STARlight Monte Carlo, and present a sketch of proposed upgrades to STARlight.

PHOTOPRODUCTION OF \ETA_{C} MESON IN ULTRAPERIPHERAL PB-PB COLLISIONS AT \SQRT{S_{NN}}=5.02 TEV AT ALICE

Alec Peck, Creighton University, Omaha, NE

High energy ultraperipheral collisions provide unique circumstances to examine the exclusive photoproduction of heavy mesons. The Pb-Pb collisions generated at CERN's Large Hadron Collider at √(s_NN)=5.02 TeV provide new data which has been predicted to have a reconstructable signal for the ηC meson. Analysis of the Run 2 Pb-Pb collisions for evidence ηC production is performed using six decay channels for the ηC. STARlight and PYTHIA8 Monte Carlo simulations can be used to understand the detector acceptance for each channel. I will discuss the selection results from each analysis stage, the final ηC candidates, and the preliminary results for possible parent particle signals in the data.

CONSTRAINTS ON THE GEOMETRY OF QUARSAR SPECTRA

Leo Moraczewski and Jack Gabel, Creighton University, Physics Department, Omaha, NE

Current quasar models assume a super massive black hole in the center of the quasar, with an accretion disk surrounding it. The accretion disk is believed to be a rapidly rotating, geometrically thin but optically thick disk. The orientation of the accretion disk is predicted to have a significant effect on the observed spectral emission features of quasars. We present initial results testing that model based on a study of the rest frame UV and optical spectra using the data in the Sloan Digital Sky Survey quasar spectral database, Data Release 12. Using the [OIII] emission line equivalent width as a measure of the disk inclination angle, we test various emission line and continuum features in different parts of the spectrum, which could provide insight into outflowing winds and the overall geometry of quasars.

EARTH SCIENCES

THE IMPACT OF AN INCREASED PERCENTAGE OF RAINFALL DURING HEAVY PRECIPITATION EVENTS ON RECHARGE AND CROP PRODUCTION IN A REGION OF NEBRASKA

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Climate change has broad impacts on Earth systems, including precipitation. From 1958 to 2012, there was a 16% increase in the amount of rain falling in very heavy events in the Midwest. Changes in the variability of precipitation with an increase in rainfall occurring during heavy rain events may lead

to changes in the recharge rate of the High Plains Aquifer and productivity in crops. The effect of these precipitation changes on the High Plains Aquifer is modeled in an area of Nebraska between the Platte and Republican Rivers using a groundwater model produced with MODFLOW 6 and a crop model produced in DSSAT. According to the USGS, about 30% of the water used for irrigation nationwide comes from the High Plains Aquifer, so changes that affect crop production are incredibly important to agriculture.

GROUNDWATER DECLINES IN THE SAND HILLS IN THE VICINITY OF AINSWORTH, NEBRASKA

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The Sandhills of northwest Nebraska is a hydrologically important region as it contains two-thirds the total water of the High Plains Aquifer. Groundwater and surface water in this region are shown to be highly interconnected. Recharge rates can be illustrated using observational data in relative rise or fall of water table elevation. Investigations into five-year groundwater trends in the Middle Niobrara Natural Resources District showed a rise on average of 3.4 ft in water table, whereas data collected near the Bone Creek north of Ainsworth, Nebraska shows an average decrease of 5 ft. Further examination of the dataset revealed this trend has been fairly consistent since the beginning of the data set in 1963.

IMPACT OF JOINT REACTIVATION ON RESERVOIR QUALITY: A CASE STUDY FROM SATANKA-INGLESIDE FORMATION, CARTER-LAKE QUADRANGLE, COLORADO

Shashank Khatri and Caroline M Burberry, Department of Earth and Atmospheric Sciences, University of Nebraska at Lincoln, NE 68588

The damage zone around a fault is characterized by deformed wall rocks which result from initiation and propagation of slip along faults. Previous studies have also established that the damage may accrue due to slip along an already established surface because of stress cycling in response to the passing of geometric irregularities along the surface. Therefore, reactivation of a pre-existing joint should lead to formation of a damage zone adjacent to the joint surface. To evaluate this hypothesis, microscopic characteristics of the host rock adjacent to a reactivated joint in the Satanka-Ingleside Formation, Colorado (Eastern Foothills Belt of the Front Range) were evaluated. There is development of a thin comminuted gouge seam, adjacent to the reactivated-joint surface, enveloped in a zone of increased intragranular microfracturing, compaction, and preferential cementation. Additionally, the absence of transgranular fracturing in the cemented strain-hardened rock around the strike-slip-reactivated-joint is indicative of non-diagenetic, post-reactivation cementation, compaction and reduction of porosity. Naturally jointed sandstone reservoirs are modelled as having dual permeability in hydrocarbon and hydrogeological fluid flow simulations with joint aperture distribution controlling the flow through joints, and the host rock permeability structure controlling the fluid flow through the matrix. The results from this study show that reactivation of a pre-existing joint accrues impermeable micro-damage around the reactivated joint surface, which negates any fluid interaction between the conduit joint and permeable host rock, and thus, the reservoir cannot simply be modelled as having dual permeability. The results from this study will help enhance fluid flow models used in hydrogeological and hydrocarbon reservoir modelling studies, and in 3D modelling of fluid flow and flow velocities through fractured reservoirs in environmental studies.

EVALUATION OF THE POTENTIAL GEOLOGICAL AND SOCIOECONOMIC IMPACTS OF THE IMMINENT CASCADIA MEGATHRUST EARTHQUAKE

Matthew Pritchard, Caroline M Burberry, and Irina Filina, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, NE 68588

The Cascadia Subduction Zone on the northwest coast of the United States poses a threat of a devastating megathrust earthquake and subsequent tsunami damaging coastal populations. This paper synthesizes literature to analyze the geologic and socioeconomic effects of this natural disaster, as well as examines the existing warning system infrastructure and makes recommendations to mitigate the damage. In order to assess the geologic effects of a megathrust earthquake, we investigate tectonic history, the role of episodic tremor and slip (ETS) in stress buildup, and the current geometry of the subduction zone. This information is then used to assess the socioeconomic effects of a megathrust earthquake. Demographic, geographic, and temporal information of the coastline are used to assign relative vulnerabilities to individual communities, pinpointing the areas at highest risk. Both geologic and socioeconomic effects are incorporated into an evaluation of ShakeAlert, the warning system in development for Cascadia. Recommendations for preemptive measures and warning system design are then made, incorporating all factors.

INTEGRATED GEOPHYSICAL ANALYSIS OVER THE CASCADIA SUBDUCTION ZONE

Asif Ashraf and Irina Filina, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, NE 68588

Along the north-western coastline of USA, the Cascadia Subduction Zone is at imminent risk of producing megathrust earthquake. In this convergence tectonic regime, oceanic Juan de Fuca plate subducts beneath continental North American plate. This study focuses on developing an integrated subsurface model from multiple geophysical datasets. Publicly available seismic, potential fields (gravity and magnetics) and earthquake data will be jointly interpreted to construct the subsurface model across this subduction zone near the states' border of Washington and Oregon. Joint analysis of several geophysical datasets is more robust than modeling only one of them because each surveying method depends on their own corresponding physical property of subsurface. Gravity and magnetic fields will constrain density and magnetic susceptibility of subsurface rocks, while the seismic image will provide a framework for the subsurface architecture. The derived model will allow investigating the overall physical properties of subsurface rocks.

THE HUMBOLDT FAULT: AN OBLIQUE SLIP STRUCTURE IN PENNSYLVANIAN LIMESTONE

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The Humboldt Fault marks the surface exposure of the Eastern flank of the Nemaha Uplift but is rarely clearly exposed due to the general scarcity of outcrop in SE Nebraska. We present a new outcrop of a fault strand near the town of Humboldt, NE, coupled with an interpretation of well tops, showing that the structure is complex, with a similarly complex sense of movement. The outcrop is found in a Pennsylvanian limestone rich in Fusulinids, interbedded with calcareous shale, possibly the Tarkio Formation. Outcrop data show that the fault surface strikes N-S and is near-vertical in dip, with steeply pitching lineations indicating dominantly reverse slip with a small oblique component. Corrugations on the fault plane indicate a component of strike-slip motion on the fault strand, possibly earlier than the reverse slip. Comparison with nearby wells, e.g. the King-1 well and the Thomas D Carsh-1 well, reveal an offset of approximately 400 ft on the top Tarkio unit, based on tops from the NOGCC scout

tickets. Our outcrop falls between these two wells, confirming that the reverse offset observed at outcrop is consistent with the drilled data. The new outcrop is approximately on-trend with faults discovered by workers in the Martin Marietta open-pit quarry to the south, in the Pennsylvanian cyclothem units. We further interpret these data to confirm the widespread hypotheses that the Nemaha Uplift is a transpressional fault zone, composed of a series of fault strands and pop-up structures, formed from multiple reactivation events in the Ancestral Rocky Mountains Orogeny and the Laramide Orogeny.

INVESTIGATING ON CONTRADICTORY PATTERN OF SEAMOUNTS NEAR SIERRA LEONE RISE

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This study focuses on the Bathymetric Seamounts (BSM) in the Atlantic Ocean, located north of the Sierra Leone Rise on the African tectonic plate. Seamounts are formed by volcanic activity and are common along oceanic transform faults; they are also associated with hotspots, such as the hotspot beneath the Hawaiian Islands. The trend in location of seamounts can help determine the direction of tectonic plate motion. The BSM show a southwest to northeast trend, however, this contradicts the expected west to east motion of the African tectonic plate. The current hypothesis to explain this pattern is related to the Sierra Leone plume located south of the BSM. The stretching of the plume could have formed the seamounts, resulting in the observed trend. In this case, the age of the seamounts should increase with distance from the Sierra Leone plume. However, the ages of the seamounts remain unknown due to lack of geological samples from the study area. This hypothesis can be tested with the analysis of magma chamber sizes beneath the seamounts, which can be determined from geophysical methods. The purpose of this study is to perform a literature review in order to prepare for future geophysical analysis, and gather various geophysical datasets such as bathymetry, seismic, and potential fields from public domain sources.

CHOOSING THE BEST LOCATION FOR A GRAVITY BASE STATION

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Gravity surveying requires tying the relative gravity readings to an absolute gravity base station. Without gravity ties the data collected is meaningless. There is no publically accessible gravity base station in Lincoln, NE. There is an unofficial NOAA station at the Lincoln Airport that requires a special permit to access. The UNL Geophysics Team completed two local gravity surveys tied to the unofficial station and found a consistent error of approximately 40 mGal between our measurements and the published USGS data. A new, publically accessible gravity base station is necessary in Lincoln. Therefore, the primary objective of this project is to choose the best location for this new gravity base station on the UNL campus. The location will be determined by analysis of several factors including location, proximity to parking, special events that may restrict access, noise levels, permanence, etc. Four possible locations have been identified with ongoing, regular gravity measurements starting in October 2019. The purpose of the measurement is to collect sufficient data in order to perform a statistical analysis of noise levels. The expected results of this project are defining the best location for a gravity base station on the UNL campus.

MAPPING SUBSURFACE FAULT SYSTEM USING A DRONE-BASED MAGNETIC FIELD SURVEYING SYSTEM

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The Northern Bounding Fault of the Midcontinent Rift System in eastern Nebraska represents a contact between rocks with strikingly different magnetic properties. This allows geoscientists to utilize magnetic surveying to map the fault. A high resolution airborne magnetic survey system assembled by the UNL Geophysics Team was employed to study this fault near Venice, NE.
The platform used for this study is a drone based magnetic surveying system. This was developed by mounting a Scintrex ENVI-PRO magnetometer onto a DJI Matrice 600 Pro umanned aircraft system. A 200 square meter magnetic survey was designed and conducted over the Northern Bounding Fault. The magnetic anomaly was found by subtracting the expected ambient magnetic field from the recorded total magnetic field data. Magnetic anomaly and the positioning data recorded by the drone was then processed in order to compose a magnetic anomaly map. Statistical analysis of magnetic readings in the crossing points was conducted to ensure the reliability of the measurments. The composed map showed variations in magnetic field associated with the subsurface fault. However, the the fault strike inferred from the magnetic anomaly map suggests some deviations from the published trend. Moreover, we conclude that the fault appears to be segmented. Further mappng of the fault in a future survey of the adjacent block will help to understand the overall fault system. The operating procedures developed in this experiment will be used for the future surveys.

CANADIAN ARCTIC MARINE DIATOM BIOSTRATIGRAPHIC RECORDS TO ILLUMINATE THE 'DARK AGES' OF EARLY DIATOM MORPHOLOGIES, EVOLUTION AND RADIATION

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Diatoms have been important element of the biosphere since the Jurassic(?) and certainly since the earliest Cretaceous. Early records of their origin, radiation and subsequent morphological experimentation are sparse, with large stratigraphic and geographic gaps in the available record. An excellent 'Burgess Shale-level' occurrence of exquisite preservation of diatoms from Albian age sediment drillcores from Antarctica peers upwards into a the dark ages for diatom biostratigraphy little to no information is available to illuminate changes that led to the expansion of this group into the widespread siliceous deposits of Campanian and younger ages. A series of outcrops in the Canadian High Arctic of Turonian to Campanian age shales of the Kanguk Formation provide important new occurrences of marine diatoms in stratigraphic successions on Axel Heiberg Island that will reveal the early history of this important group of eukaryotic autotrophs.

INVESTIGATING THE ONSET OF THE CAMPANIAN–MAASTRICHTIAN PALEOCEANOGRAPHIC EVENTS AT DSDP HOLE 525A USING CALCAREOUS NANNOFOSSIL AS A TEMPERATURE PROXY

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The late Campanian through Maastrichtian was characterized by a long-term cooling trend that marks a transition from extreme greenhouse conditions to cooler conditions in addition to major paleoceanographic reorganization. Calcareous nannofossils are sensitive indicators of surface water conditions, making this fossil group a useful proxy for understanding Late Cretaceous

paleoceanographic events. This study expands on the work of Dr. Nicolas Thibault that explored the paleoclimatic evolution of Maastrichtian calcareous nannofossils from Deep Sea Drilling Project (DSDP) Hole 525A located in the South Atlantic Ocean. The completeness of its late Campanian – Maastrichtian record makes Hole 525A an ideal site for this study.
A total of 72 smear slides from DSDP Hole 525A, spanning approximately 74–66 Ma, were analyzed. Absolute abundances were determined by counting ~300 specimens and two additional traverses were scanned for rare species. Statistical methods were used to compute species richness, Shannon Diversity, evenness, and Principal Components to identify changes in the nannofossil assemblage. The taxa Micula decussata, Biscutum spp., Prediscosphaera cretacea, Prediscosphaera spp. and Watznaueria barnesae are significant principal components of the assemblage. In order to determine the possible source of variance in the assemblage, these taxa were compared to the diversity indices and the conventional carbon and oxygen isotope data derived from foraminifera. Traditionally viewed as taxa with either no known or different paleoecological affinities, these taxa appear to have occupied new paleoecological niches that responded to paleoceanographic changes at DSDP Hole 525A. More specifically, Micula decussata, Biscutum spp., Prediscosphaera cretacea, and Prediscosphaera spp. appear to be driven by changes in paleofertility, while Micula decussata and Watznaueria barnesae abundances were plausibly controlled by paleotemperatures. Isotopic data and tectonic reconstructions suggest that paleoceanographic changes were caused by mixing of water masses due to tectonic sill subsidence; changes in the calcareous nannofossil assemblage corroborate these hypotheses.

CONODONT BIOSTRATIGRAPHY AND SPECIES DIVERSITY IN THE PALEOZOIC UPLIFT OF THE CENTRAL AND NORTHERN ROCKY MOUNTAINS

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The lack of recent conodont research in the Rocky Mountain basins provides a unique opportunity to contribute to the field of microfossil paleontology research. Conodont identification and biostratigraphy have played a major role in collaborating the geological timescale in the Paleozoic and Triassic. Rocks collected from three basins in Wyoming: Big Horn, Powder River and Wind River, along with samples collected from the Williston Basin in South Dakota (Spearfish) may provide important conodont insight (areas of interest are basins in the Colorado Rockies). A total of 30 samples including limestones, shales, sandstones and dolomites, ranging from 1-2kg, were collected. These rocks were from formations ranging from Cambrian to Permian age, offering the possibility of studying 290 Ma. of conodont evolution. Traditional acetic acid dissolution of rock was used to extract the conodonts. Diesel fuel was used to help break down silt or clay-rich rock, which applied to almost a quarter of the samples. Acetic acid with a buffer (sodium acetate) was used to break down limestone and dolomite. A rifle flume heavy liquid separation using Sodium Metatungstate was used to separate apatite fossils from lighter minerals. Data collection is still actively underway.

NEW RADIOCARBON DATES FROM ISOLATED CANYON FILLS ON THE CAMPUS OF CHADRON STATE COLLEGE, CHADRON, NEBRASKA

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The evidence for the evolution of landscapes is recorded—often in piecemeal fashion—in clastic fills of valleys incised into the bedrock or into pre-existing fills. Incision and filling are episodic, and timing of these events can be worked out by studying the field relationships and fossil content of the fills. Northwestern Nebraska′s Pine Ridge is an escarpment formed in response to incision of the White River, a process driven in part by tectonics and erosional exploitation of underlying structures.

Two fossiliferous outcrops on the campus of Chadron State College give us new data points from the complex of cuts and fills in this region. Radiometric ages of fossil wolf (Canis lupus) and bison (Bison sp.) yielded ages of 745±15 and 1550±15 radiocarbon years before present, respectively. We do not know whether these represent two separate filling episodes separated by downcutting, or if they were part of one ~800-year-long period of sediment accumulation. However, the 745-year date does give us a maximum date for the start of the modern downcutting episode, which resulted in a deep canyon with the fossiliferous clastic remnants hanging on the canyon walls. More exploration of the relatively abundant Quaternary and older fills in the Pine Ridge will be necessary in order to complete our understanding of the complex evolution of this region.

MIOCENE GEOGRAPHIC VARIATION OF BIOMES IN NORTH AMERICA FROM STABLE ISOTOPES IN LARGE HERBIVORES

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During the Miocene, North America experienced many abiotic and biotic changes. Combined climatic forcing and environmental feedbacks, as well as a long-term cooling trend with increasing aridity fundamentally changed regional terrestrial biomes from densely vegetated landscapes to open canopy ecosystems. Towards the end of the Miocene, plants utilizing C_4 photosynthesis increased in biomass and ungulate diversity shifted with a large peak in browser diversity in the middle Miocene. To examine how these changes in biomes vary temporally and spatially, we use stable carbon isotopes from fossil mammal enamel. Stable carbon isotopes in C_3 dominated environments reflect vegetation density and herbivores that consume that vegetation record dietary values in their tissues. We used published herbivore enamel stable carbon isotope values to recreate representative communities from various regions across North America throughout the Miocene. To interpret regional paleoenvironments, we use a predictive model based on $\delta^{13}C$ values in modern C_3 dominated biomes that adjusts for difference between modern atmospheric $\delta^{13}C$ values and Miocene values, for latitudinal and altitudinal differences in $\delta^{13}C$ plant values normalized to a central datum, and for average diet-to-enamel $\delta^{13}C$ enrichment for ungulates.

Results show that regional mean $\delta^{13}C$ faunal values from most regions plot above closed canopy C_3 values indicated from the model which is consistent with previous interpretations of the timing of opening environments. Some regions show a trend towards more positive carbon isotopes towards the Pliocene, but this may be due to dietary incorporation of C_4 grasses rather than a change in openness. Comparisons between coastal and intercontinental regions indicate that the timing of changes in vegetation density differed as did homogeneity of habitats within biomes. Overall, the opening of habitats and change in vegetation density in the Miocene of North America was not a synchronous progression of events.

PALEOLIMNOLOGICAL RESPONSE OF ECUADORIAN LAGUNAS FONDOCOCHA AND PIÑAN TO LOCAL AND REGIONAL STRESSORS OVER THE LAST TWO MILLENNIA

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Tropical Andean páramos are wet alpine grassland and shrub ecosystems that lie above the tree

line and below the permanent snow line in Colombia, Venezuela, and Ecuador. Increasing surface air temperatures and human influences (e.g. agriculture, tourism) are altering Andean páramo ecosystems. Páramo landscapes contain a large number of permanent and temporary waterbodies, making them ideal candidates for paleolimnological analysis. Changing climate and human influences are evident in shifts in the diatom species composition in sediment cores from the region that span the last ~150 years, however these studies are limited by their short temporal scales and limited spatial extent. Two lake sediment cores spanning the last two millennia were analyzed for changes in diatom species composition and geochemistry to provide a longer-term perspective of lake environmental change. The two lakes respond to different external stressors. Laguna Fondococha experienced shifts in dominance between two Aulacoseira species and increases in the abundance of benthic species, which is interpreted as evidence of lake-level fluctuation through time. The Laguna Piñan, on the other hand, shows a linear shift in the diatom assemblage from those tolerant of high dissolved organic carbon (DOC), low pH, and low nutrients, to an assemblage characteristic of lower DOC, higher pH, and higher nutrients. These shifts are correlated with deposition of tephra in the sediment core, suggesting that volcanic deposition may have locally altered the catchment geochemistry, in turn altering the lake geochemistry.

APPLICATIONS OF PXRF IN ANALYZING GEOCHEMICAL SIGNATURES IN A SUITE OF MARS 2020 MISSION ANALOG ROCKS

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Portable X-ray fluorescence (pXRF) technology provides a rapid, non-destructive method for determining the elemental composition of rocks and soils. PXRF can be performed in situ, making it particularly useful for Mars and planetary research because the geology encountered by rovers can simply be analyzed on the spot via XRF spectroscopy and then relayed back to Earth for evaluation. The primary goal of our pXRF study has been to isolate geochemical signatures in Mars analog rocks of the Mojave Desert, California, to find a possible indicator that can differentiate rock-forming minerals that were produced inorganically and those that may have formed through biological activities. The approach for our research included three parts: (1) research of sites on Earth with rocks that are similar to Mars and could function as an analog, (2) developing a methodology for in situ pXRF data gathering that could be useful to the Mars 2020 rover mission, and (3) quantitative analysis of the collected data. Two outcrops in the Tecopa region of the Mojave Desert were chosen as analog sites and the geochemistry was mapped with an Olympus Vanta C pXRF. The first location contained lake beds of alternating mudstone and gypsum layers. Preliminary analysis has identified silicon, calcium, and aluminum as the most abundant major elements found, with minor concentrations of sulfur. The second outcrop consisted of dolomite and displayed three different types of stromatolite structures in alternating layers ranging from 0.1-1.3 meters thick. Silicon, calcium, and magnesium have been detected as primary elements, with small concentrations of strontium and zinc. Currently it is not clear whether the geochemical signatures detected in these rocks can reasonably point to a distinction between biologically or inorganically formed materials, but the extensive data is still undergoing further analysis.

DISSOLUTION OF BEDROCK APATITE ($Ca_5(PO_4)_3(OH,F,Cl)$) AS A SOURCE FOR PHOSPHORUS TO AQUATIC ECOSYSTEMS OF THE LOCH VALE WATERSHED, ROCKY MOUNTAIN NATIONAL PARK, COLORADO

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Phosphorus and nitrogen are two important nutrients to freshwater ecosystems and capable of

modifying quantities of algal biomass. Nitrogen is a common constituent of atmospheric deposition, while bedrock is the most common natural source of phosphorus. Lakes and streams in the glaciated Loch Vale watershed (LVW) of Rocky Mountain National Park are experiencing increases in algal biomass despite being located in remote wilderness. The LVW is situated mostly above tree-line and is dominated by bare rock and talus with a mean annual temperature of 1.4 ºC. Previous research has demonstrated that human activities within the western High Plains of Colorado have resulted in increases in atmospheric nitrogen deposition to the LVW starting in the mid-20th century. However, identifying and quantifying sources of phosphorus to natural waters is complicated by ecosystem cycling and phosphorus having only one isotope.

Phosphorus dynamics in the LVW has been investigated using a three-fold approach: (1) Field-based atmospheric precipitation and stream water chemistry data for 1984 to 2008; (2) a laboratory plug-flow column reactor containing crushed bedrock from the LVW; and (3) the geochemical kinetic and thermodynamic modeling using PHREEQC software. The field-based data provided a LVW bedrock mineral apatite ($Ca_5(PO_4)_3(OH,F,Cl)$) average dissolution rate of 47 moles P^{5+}/hectare/year to aquatic ecosystems, ~18 times higher than the modelled global average. Both the laboratory column reactor and PHREEQC simulations demonstrated that apatite dissolution is significantly suppressed when calcite ($CaCO_3$) is simultaneously dissolving. The relatively rapid dissolution apatite in the LVW is likely attributable to a damaged crystalline structure produced when radioactive isotopes of uranium underwent alpha-particle emission through geologic time. The increases in algal biomass occurring presently likely reflects enhanced anthropogenic nitrogen deposition occurring since the mid-20th century, combined with naturally elevated phosphorus levels.

THE CONTRADICTIONS IN TECTONIC MODELS OF THE GULF OF MEXICO

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The opening of the Gulf of Mexico represents an important stage of the break-up of the Pangaea supercontinent. Despite the petroleum exploration in the basin started more than a century ago and multiple geological and geophysical dataset has been acquired in the basin, its tectonic history remains poorly understood. Published tectonic models of the Gulf of Mexico differ dramatically in the key points, such as the timing of the basin opening, the pre-breakup configuration of the crustal blocks, the styles of the continental rifting and the consequent seafloor spreading. The published tectonic reconstructions of the Gulf of Mexico are based on a good fit between the individual crustal blocks. However, this fit does not provide a match of the distinct geological structures on the “conjugate” margins, suggesting that the major revisions in the tectonic model of the Gulf of Mexico are necessary. This paper aims to review the published tectonic models of the Gulf of Mexico, highlight their similarities and discrepancies, as well as to check them against known geological constraints on the “conjugate” margins.

SURFICIAL FRACTURES IN THE NAVAJO SANDSTONE, SOUTHWESTERN USA: THE ROLES OF THERMAL CYCLES, RAINSTORMS, GRANULAR DISINTEGRATION, AND ITERATIVE CRACKING

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Deep (> 5 m) sheeting fractures in the Navajo Sandstone are evident at numerous sites in southern Utah and derive from tectonic stresses. Strong diurnal thermal cycles are, however, the likely

triggers for shallow (< 0.3 m) sheeting fractures. Data from subsurface thermal sensors reveal that large temperature differences between sensors at 2 and 15 cm depth on clear summer afternoons are as great as those that trigger sheeting fractures in exposed California granite. Extensive polygonal patterns in the Navajo are composed of surface-perpendicular fractures and were produced by contractile stresses. Numerous studies have shown that porewater diminishes the tensile strength of sandstone. Based on our thermal records, we propose that cooling during monsoonal rainstorms triggers polygonal fracturing of temporarily weakened rock. On steep outcrops, polygonal patterns are rectilinear and orthogonal, with T-vertices. Lower-angle slopes host hexagonal patterns (defined by the dominance of Y-vertices). Intermediate patterns with rectangles and hexagons of similar scale are common. We posit that outcropping fractures are advancing downward by iterative steps, and that hexagons on sandstone surfaces (like prismatic columns of basalt) have evolved from ancestral orthogonal polygons of similar scale. In lava flows, fractures elongate intermittently as they follow a steep thermal gradient (the source of stress) as it rapidly moves through the rock mass. In our model, a steep, surficial thermal gradient descends through unfractured sandstone, but at the slow pace of granular disintegration. Through time, as the friable rock on stable slopes erodes, iterative cracking advances into new space. Hexagonal patterns form as new fractures, imperfectly guided by the older ones, propagate in new directions, and vertices drift into a configuration that minimizes the ratio of fracture length to polygon area.

ENVIRONMENTAL SCIENCES

COMPARISIONS OF STOMATAL DENSITIES IN CENTURY-OLD AND CURRENT EASTERN NEBRASKA PLANT LEAVES

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The rapid increase of carbon dioxide in the atmosphere during the last century has raised questions on the impact to plant life. Stomatal densities have been shown to vary due to ambient carbon dioxide concentrations. The purpose of this study was to compare stomatal densities of century-old and present-day leaf samples collected in eastern Nebraska. Viola pedatifida, Syringa vulgaris, and Prunus virginiana leaves were examined. Stomata were counted in six 548x548 μm plots on the lower surface of each leaf sample by using a scanning electron microscope. T-tests (alpha 0.05) were used to find statistical significance. The results indicated that stomatal density was significantly greater in century-old Viola pedatifida and Syringa vulgaris as compared to current leaves. Factors that may have contributed to these results will be discussed.

PHYLOGENETIC PLACEMENT OF *MONOCHILUS* (LAMIACEAE) WITHIN THE SUBFAMILY AJUGOIDEAE

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The Lamiaceae (mint family) has about 7000 species, is found virtually worldwide, and is subdivided into 12 subfamilies. Ajugoideae is the third largest subfamily of Lamiaceae, occurs on every continent, and includes 23 genera and about 760 species. Previous studies have largely clarified relationships within Ajugoideae, but the genus *Monochilus* has never been included in a molecular phylogenetic study. *Monochilus* is made up of only two species endemic to eastern Brazil: *Monochilus gloxinifolius* and *M. obovatus*. Based on morphological features, it is predicted that the closest relative of Monochilus is the South American genus *Amasonia*. Here, we extracted DNA of *Monochilus* from dried leaf material, amplified targeted gene regions via PCR, and, for the first time, use a molecular

phylogenetic approach to determine the phylogenetic placement of *Monochilus* within the subfamily Ajugoideae.

USE OF SNAILS AS INDICATORS OF ECOSYSTEM HEALTH

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Many studies associate healthy freshwater ecosystems with aquatic insect diversity and, more recently, with trematode diversity. However, few studies have asked if the relationship between aquatic freshwater snail diversity correlates with a healthy ecosystem. To address this question, we gathered snails from three freshwater sources in Pine Ridge, South Dakota and one reference site at Lacreek National Wildlife Refuge. At each site, three researchers spent 15 minutes inside a 3 x 10 meter transect sampling for snails. The next 15 minutes were dedicated to collecting aquatic insects. Snails were identified before being dissected for trematodes, which were also identified. We calculated the Simpson diversity indices for snails, insects and trematodes. Three of the four sites had either zero or one trematode species. The reference site (Lacreek) had a Simpson index of 0.55 for trematode diversity. Insect diversity (at the family level) at all four sites had Simpson indices that ranged from 0.57 (at the reference site) to 0.51 at the most disturbed site. Snail diversity was highest at a rural park in Pine Ridge (0.68) and lowest at a rural fishing site in Pine Ridge (0.08). Our results suggest that insect diversity may be a more reliable measure of ecosystem health than snail or trematode diversity. However, further analysis of the insect data (at the genus level) may change this conclusion.

REPRODUCTIVE ECOLOGY OF WATER-POLLINATED STUCKENIA PECTINATA

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Water pollination (hydrophily) is a rare pollination mechanism by which pollen is transported to stigmas via the water surface or underwater currents. Little is known about the consequences of the transition to hydrophily for postpollination pollen development. The goal of this study was to characterize the progamic phase, the life history stage between pollination and fertilization, in the water pollinated monocot, Stuckenia pectinata. Flowers were hand pollinated and collected at 5-15 minute intervals for two hours after pollination. In order to document the timing of pollen germination, stigmas were removed, stained with aniline blue, and imaged with light microscopy. The germination status of each pollen grain was documented. Pollen germination occurred as soon as 5 minutes after pollination. In order to characterize pollen tube growth, carpels were cleared in NaOH, stained with aniline blue, and the length of the longest pollen tube was measured. Results in Stuckenia will be compared to related hydrophilous species to better characterize this life history stage in water pollinated plants.

TEACHING OF SCIENCE AND MATH

INNOVATION OF CANNABIS EDUCATION

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The increased legalization of cannabis and industrial hemp in the US resulted in an increased demand for educated professionals across agriculture, processing, wellness and manufacturing industries. Doane University has created a Cannabis Science and Industries: Seeds to Needs Professional Certificate Program for learners who wish to gain knowledge of this emerging U.S. industry. The courses cover topics of cannabis science, wellness aspects of cannabis products, cultivation, seeding, cloning, genetics, tissue culture, harvest, processing, regulations, safety, compliance, economic impact, and professions in the cannabis industry. The courses were created by experts in both academia and

the cannabis industry and are designed for enrolled students seeking greater insight or entry into this industry. The courses are online, self-paced, and offer in-depthand relevant learning materials to meet the diverse needs of learners, inspiring professionals, farmers, physicians, technicians and more.

IMPLEMENTING THREE-DIMENSIONAL SCIENCE STANDARDS: A LOOK AT TRANSFORMATIONAL COACHING

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Implementation of three-dimensional science instruction called for in the A Framework for K-12 Science Education (2013) and the Nebraska College and Career Ready Standards for Science (2017) requires a shift for teachers in planning and instruction, as well as mental shifts for students in their expectations of how learning is done. A professional development program was designed and implemented to support teachers with the transition to the new standards. With a team of science educators trained in transformational instructional coaching, a variety of learning experiences (conference attendance, lesson study, content immersion, and curriculum writing) were offered to teachers and supported by the instructional coaches. Results over the final 15 months of a 4-year program showed changes in participating teachers' beliefs and practices in science instruction, and positive relationships between student interest and engagement and teacher perception of how inquiry based their lessons were, from self-reported data.

STUDENT REFLECTIONS HELP BOTH STUDENTS AND INSTRUCTORS SEE GAINS IN LEARNING

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Oftentimes experiential courses rely heavily on assessment of a final project. It may be hard to discern what challenges and growth students are experiencing formatively. In my scientific methods course, students designed and conducted experiments to answer original research questions. In a reflection, assigned shortly after experiments were set up, students addressed challenges and difficulties they encountered and shared what they learned in the process. This assignment provided insights into what students learned that was not necessarily revealed in the final projects. In reflections, students identified criteria for developing successful experiments, admitted frustration dealing with technical aspects of research, and recognized the important community aspect of science. Besides helping students acknowledge their own learning, the reflections confirmed, for the instructor, the value of the in-class research projects.

DIY ADAPTIVE IMMUNITY DRY LAB: HOW TO CREATE YOUR OWN ADAPTIVE IMMUNITY MODELS TO ENHANCE YOUR GENERAL MICROBIOLOGY OR PHYSIOLOGY LAB

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Teaching the intricacies of the adaptive immune response can be difficult for biology instructors. Few hands-on laboratory activities are available, and it is particularly challenging for schools with limited laboratory facilities and resources. Creating props using colorful clothes pins, pop sickle sticks, a glue gun, porcupine balls, and more, creates a role-playing classroom experience. This allows students to act out how an antigen-presenting cell can launch either the humoral or the cell-mediated immune response. After providing the foundation for this activity, I will demonstrate how this exercise can be expanded to explain immune disorders, such as allergies and autoimmunity.

CONCEPT MAPS IN SCIENCE COURSES. YES OR NO?

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Mapping concepts seems to be an effective way of building upon previous knowledge by connecting newly acquired information back to it. It has been demonstrated by various studies that integrating new information with and connecting to previously acquired information is easier for students to understand and remember. A concept map is a visual organization and representation of information seeking relationship within and between various topics. Well created map shows connection among information, concepts and ideas. Concept maps are commonly used in clinical courses for health care professionals. Complex and critical thinking is an essential tool for powerful outcomes in patient care. An open-minded health care professional can learn beneficial lessons from other's critical thinking. We have used concept maps assignments in an online undergraduate Advanced Pathophysiology course, which is taken by traditional students as well students with substantial clinical experience seeking to advance their education. Combination of traditional and non-traditional, clinically well prepared students in the same cohort enhanced, in our opinion, creation of excellent concept maps. We share our experience and students' feedback provided after completing the online course.

DOES BLENDING OF UNDERGRADUATE COURSE CONTENT AND RESEARCH OPTIMIZES ENGAGEMENT AND LEARNING?

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Undergraduate research benefits both students and faculty. Incorporating a research component into curriculum provides opportunity for students to develop critical thinking skills. The research process also affects valuable learning experience. One of the modules in the undergraduate Advanced Pathophysiology course is Pathophysiology of Endocrine Disruptors. Endocrine disruptors are chemicals found in terrestrial and aquatic environments and they can interfere with hormonal systems of organisms. Based on numerous studies, it is believed, that a wide range of substances act as endocrine disruptors. We have been investigating possible effects of chemicals commonly used in farming areas on singing behavior of Western Meadowlarks (Sturnella neglecta). This kind of inexpensive field research allows students to acquire skills valuable for success in graduate school or research process. We believe that undergraduate research experience can be seen as engaged learning.

BIOMECHANICAL MODELING OF THE RESULTANT FORCES INDUCED UPON THE A2 AND A4 PULLEYS WHILE CLIMBING

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The popularity of rock climbing has been increasing in recent years. Modern climbing gyms have enabled this sport to grow even in areas lacking the geographical features necessary for traditional rock climbing. This increase in climbing has been accompanied by an increase of tendon and pulley injuries within the hands. Gripping of small holds on harder routes can lead to a type of grip known as a "crimp", where the proximal interphalangeal (PIP) joint is fully flexed and the distal interphalangeal joint (DIP) is hyperextended. While this style of grip aids climbers in negotiating small holds, the resulting angle between the flexor digitalis pollicis (FDP) and flexor digitalis superficialis (FDS) tendons in relation A2 and A4* pulleys induces incredible stress upon the pulleys compared to a traditional slopestyle grip, where the DIP and PIP are mostly extended. This biomechanical model relates forces experienced by the fingertips when climbing to the resultant forces enacted upon the pulleys when using different grip styles as to better understand causative factors of climbing injuries.

COMPUTER MODEL INVESTIGATING PLEURAL EFFUSION AND ITS EFFECT ON INSPIRATORY CAPACITY AND LING FUNCTION IN AFFECTED PATIENTS

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Pleural Effusion (PE) is a common symptom for many illnesses that range from Congestive Heart Failure (CHF) to infections. PE is the buildup of fluid in the pleural potential space between the lungs and the chest wall. In clinical situations, PE can lead to death due to limited lung function. This can cause drops in blood oxygen levels that lead to hypoxia and/or pH changes in the blood such as acidosis. Clinicians need to look at multiple factors that are related to fluid release and retention to ensure the safety of the patients and to set up a treatment plan. Our computer simulation allows practitioners to access risk factors for increased fluid buildup based on multiple facets. Diet, immune state, and medications can fluctuate the fluid levels in the pleural space. The goal of our model is to offer a scheme to assess and investigate potential factors that contribute to fluid build-up and how medications can be used to treat PE.

PREDICTIVE MODEL FOR HIGH-RISK CORONARY ARTERY DISEASE

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Coronary heart disease (CHD) is one of the most frequent causes of death in adults in the industrialized countries. In coronary heart disease the blood circulation of the heart muscle is inadequate, and this is caused by a narrowing or blockage of one or more coronary blood vessels. A major complication related to CHD is acute myocardial infarction. This disease is caused by the calcification of the coronary blood vessels. The main risk factors are well known. For example, the incidence of coronary heart disease increased with age, along with that men are more frequently affected than women. Avoidable risk factors relating to coronary heart disease among both men and women include smoking, obesity, high blood pressure and disorders of the fat and sugar metabolism. Determining a person`s individual risk level and taking all risk factors into account is important for heart-attack prevention, which can be done using a model. This model can be used to assess all factors that can lead to CHD as well as take into account the factors that can decrease your chances of having the disease.

A COMPUTER SIMULATION OF ALCOHOL METABOLISM IN MALES AND FEMALES

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Alcohol metabolism is a process that occurs primarily in the liver, however, it can also take place in the brain and stomach. Alcohol is absorbed largely through the small intestine. It is carried from the small intestine to the liver through the bloodstream. In the liver the alcohol is exposed to the enzymes alcohol dehydrogenase (ADH) and acetaldehyde dehydrogenase (ALDH) and together these enzymes work to break down alcohol into water and carbon dioxide. The effects alcohol has on the body is dependent upon its blood alcohol concentration (BAC). The BAC can be influenced by factors such as age, gender, and diet. Drinking alcohol, especially heavy drinking, can put individuals at risk for health complications including alcoholism, liver damage, or cancer. In males and females with the same lean body mass, women have demonstrated faster rates of alcohol metabolism compared to males. This STELLA model demonstrates the differences gender has on alcohol metabolism leading to liver damage.

INVESTIGATING PAIN MANAGEMENT SOLUTIONS FOR FIBROMYALGIA USING A COMPUTER SIMULATION

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Fibromyalgia is a disorder where there is musculoskeletal pain accompanied with others symptoms. It is the second most common condition seen by rheumatologists, accounting for 15% of evaluating patients. Many studies have been done with regards to pain management in patients suffering from fibromyalgia. The primary method of pain management is a prescription for medication, usually non-steroidal anti-inflammatory drugs (NSAIDs) or antidepressants. We have developed a model that compares pain management methods with regards to how well the methods work. Each person is different. Not every case of pain is the same. Therefore, pain management solutions must be developed individually rather than mass produced. The goal of modeling this investigation is to find better ways of managing pain in patients suffering from fibromyalgia and teaching them about non-pharmacological solutions.

A COMPUTER SIMULATION ON THE ON THE ACCUMULATION OF BETA-OXIDATION BYPRODUCTS IN MCAD DEFICIENCY

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Medium-chain acyl-CoA dehydrogenase (MCAD) deficiency is an inherited disorder tested for in a newborn screening. This disorder is caused by a reduction in the MCAD enzyme level which is responsible for breaking down fat stores to be used for energy through the process of beta-oxidation. During periods of fasting, the accumulation of acyl-carnitines and other upstream intermediates leads these individuals to experience hypoketotic hypoglycemia. This model uses the diminution of specific enzymatic aspects to explore their overall effect on intermediate buildup using enzyme kinetics.

COMPUTER STIMULATION OF THE CORONAVIRUS SPREAD IN POPULATION

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Our world is currently in anticipation of a pandemic. The Coronavirus (CoV) is a zoonotic virus that can cause symptoms and illnesses that vary from the common cold to more serious diseases and conditions. Being that CoV is a zoonotic virus, it can only be spread and transmitted between animals and people. As of February 2020, there have been hundreds of individuals who have died from the virus and more than 20,000 confirmed cases worldwide. This particular virus has spread through short vectors including towns in China around the Wuhan community. This virus has also spread through larger vectors which includes the pathogens traveling overseas to new countries, including the United States. Recently there have been cases that developed in the United States. We developed a model to show how the virus can spread throughout many populations, not only worldwide, but also here in the United States.

INVESTIGATION OF THE CHANGE IN CEREBRAL BLOOD FLOW FROM CAFFEINE INTAKE USING COMPUTER MODELING

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Caffeine is a stimulant and the most used stimulating substance ingested worldwide. It comes

in all shapes and sizes from a liquid such as coffee to a solid such as caffeine pills or chewing gum. Whichever method of caffeine an individual may choose to ingest and/or administer to themselves also will have a varying amount of caffeine with the typical measurement for caffeine shown and/or labeled in milligrams (mg). The amount of caffeine does vary product to product however, caffeine as we have learned has the potential not only to keep humans more awake but to also reduce Cerebral Blood Flow (CBF). From multiple research experiments documented in multiple published articles there is evidence that caffeine not only has the potential to reduce CBF by almost 30% but while reduced there is a chance for an increase in resting Brain Entropy (BEN). The evidence suggests a hypothesis that chronic and/or daily use of a high dose ingestion of caffeine would potentially restrict the ability for the cerebrovascular adenosine system to make up for daily caffeine use by an individual.

INVESTIGATING THE EFFECTS OF PAINKILLERS ON LIVER FUNCTION USING A COMPUTER MODEL

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Liver disease is a serious condition that affects millions of people in the world each year. The liver is one of the most important organs in the human body. Liver function includes breaking down carbohydrates, proteins, drugs, cholesterols, and fats. Without proper treatment or diagnosis, liver disease is fatal. There are many factors contributing to liver disease, one of the most common is caused by opioid use. Overuse of opioid drugs compromises liver function and eventually leads to liver damage. Opioids are a specific drug class that are derived from poppy plants prescribed to treat pain. This drug class can be synthetic or natural. When ingested, these drugs pass through the liver. Continuous abuse of these drugs breakdown at a slower rate, which increases the severity of liver damage. There are many symptoms of liver damage including: abdominal pain, odd colored stool, dark urine, diarrhea, and fatigue. Our model is studying how painkillers affect liver function and can be used to visually teach patients about liver failure.

COLLEGIATE ACADEMY

BIOLOGY

THE LYSOGENIC CYCLE OF A BACTERIOPHAGE

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The SEA PHAGES program is a program for undergraduate students dedicated to isolating and purifying bacteriophages from the soil. Bacteriophages, or phages for short, are viruses that infect solely bacteria. These viruses can go through two different types of reproduction, the lytic cycle or the lysogenic cycle. It is thought that the lysogenic cycle is beneficial for developing phage therapy. The goal of this research was to find phages that undergo the lysogenic cycle, after being originally isolated in the lytic cycle. Ten previously isolated phages were used to test for lysogeny through a serial dilution, purification, patch assays, and verification. Multiple phages produced mesas, a halo around the plaque, indicating a potential lysogen candidate. However, no lysogens were produced or verified passed the patch assay stage. Even though no lysogens were found through this research, there is past data found in another study done at Nebraska Wesleyan University. The lysogens that are discovered are important in the potential use of phage therapy due to the uptake of DNA, rather than the lysis of the lytic cycle.

EXPLORING THE NUCLEAR LOCALIZATION OF RAG1

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Antibody variation is driven by V(D)J recombination which is facilitated by the RAG (Recombination Activating Gene) complex. This complex is degraded through Ubiquitination, where a ubiquitin protein is attached to RAG1, marking it to be broken down. This process associates on the N-terminus of RAG1. In conditions containing MLN4924, a NEDD8 Activating Enzyme inhibitor, RAG1 showed decreased degradation; similar findings have been observed when the N-terminus from the full-length structure was removed, resulting in core RAG1. To investigate how RAG1 turnover and localization changes in the presence of various inhibitors, the hypothesis predicted that RAG1 degrades in the nucleus, that MLN4924 will not affect nuclear localization, and nuclear export inhibitors will increase RAG1 degradation. By cutting the DNA of a GFP (Green fluorescent Protein) and a sample of core RAG1 through restriction enzyme digests, DNA segments were isolated. These sections were ligated together by inserting core RAG1 into the GFP plasmid, resulting in a fluorescent core RAG1. This sample, along with fluorescent full-length RAG1, and GFP were transfected into 293T cells in order to observe RAG1 localization. Fluorescent imaging showed nuclear localization patterns: GFP had whole cell fluorescence, core RAG1 showed highly fluorescent nuclear localization, and full-length RAG1 had tight nuclear localization. The transfections were then repeated with inhibitors: MLN4924, Importazole, Selinexor, and Cycloheximide. While similar localization patterns were recognized in the drug treatments, further trials are required for the results to be conclusive.

SD PRO'S SUCCESS IN PREVENTING MICROBIAL GROWTH

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Global Shield Solutions claims their SD Lab products are a safer alternative to traditional chemical cleaners due to the different methods of attack on bacteria. Typical household cleaners chemically attack bacteria and require longer periods of time to kill the germs, however, SD Labs claim their products kill germs physically by rupturing the bacteria within seconds of contact. When the product is applied, it binds to a surface and ruptures microorganisms with carbon-chain spicules. The spicules are made from the compound dragonflies secrete to prevent against infection, furthering the eco-friendly nature of the product. A rising issue is microorganisms that are becoming resistant to chemical cleaners, and SD Pro is an alternative to this problem. Due to the physical killing of microorganisms rather than chemically attacking them, Global Shield Solutions claims their product can kill all microorganisms regardless of drug-resistance capabilities. The purpose of this experiment is to support this hypothesis by completing field testing and capturing images using electron microscopy. SD Labs also claims that the effects of their products have a longer lasting effect than common household sprays, with the effects lasting up to one year depending on the method of application. Further testing of this claim will be completed in controlled lab environments at Nebraska Wesleyan University. Success of these trials will result in the confirmation of Global Shield Solutions' claims and increase the legitimacy of the product.

REPLICATION OF MAIZE CHLOROTIC MOTTLE VIRUS IN YEAST

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Currently, maize crops in East Africa, Peru, and Oregon have been affected by the Maize chlorotic mottle virus. This virus infects solely maize, causing Maize Lethal Necrosis which destroys the plants' innate ability to reach the mature age to produce fruit. In countries such as East Africa, where farmer's livelihoods are reliant solely on the maize crops, they have been detrimentally affected by

this epidemic. Developing research begins to explain how this specific virus infects the maize plant; however, due to the complexity of the maize genome, success and understanding have taken longer than anticipated. Due to this setback, Dr. Hernan Garcia-Ruiz has chosen to study the virus but within a different organism. Yeast, because it has a less complex genome, has replaced maize, with the primary goal to replicate this virus's plasmid within its background strain, YPH500. Past experiments have suggested that p50 and p111 are necessary for viral replication. Current experiments have been working towards replicating p50 and p111 within the yeast genome. These plasmids are then tested to verify the presence of the proteins, or the lack thereof. The current experiments are the initial steps towards understanding the replication process of Maize chlorotic mottle virus and the possible development of a solution on how to protect maize from this detrimental disease.

AEROBIC EXERCISE AND ITS EFFECT ON REACTION RATE

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The purpose of this study was to examine the effects of aerobic exercise on cognitive performance by means of reaction rate testing. It was hypothesized that after aerobic exercise, a decrease in reaction rate would be observed. Eighteen participants were initially tested for their resting reaction rate, allowing time for practice to avoid improvability numbers affecting study, and blood pressure measurements were taken. The participants were then asked to perform the Harvard Step Test, consisting of five minutes of aerobic exercise. Immediately following the physical test, participants repeated the reaction rate and blood pressure testing. After the experimental testing, average reaction rates from each individual before and after exercise were averaged. These averages were compared using a student's t-test where a p-value of 0.493 proved statistical significance between reaction rate before and after exercise. This also proved the hypothesis that reaction rate would decrease after aerobic exercise. In conclusion, aerobic exercise in the form of the Harvard step test leads to a faster reaction rate. Because of the growing popularity of the subject of cognitive and physiological health in terms of exercise leading to many health benefits, this research serves as a good foundation for more studies to be done.

RESTING HEART RATE VARIABILITY (HRV) IN MALE VS. FEMALE COLLEGE STUDENTS

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A person's heart rate has natural variations in the time between two consecutive heart beats. This is known as heart rate variability (HRV). More specifically, HRV is the measure between R-R intervals, or the time between two consecutive R-waves of the QRS complex given by a reading from an electrocardiogram (ECG). HRV is influenced by a variety of factors such as hormones, exercise, metabolism, emotions, and physical or mental stress. Previous research has shown that those who are more active and/or healthy tend to have an increased HRV. Other studies have shown that individuals who are older tend to have a decreased HRV as compared to those who are younger. When it comes to the influence of biological sex on HRV, research is either lacking or conflicting. The purpose of this study was to determine if there was a difference in average heart rate variability of male versus female college-aged students. A total of 16 students participated, 10 female and 6 male, all between the ages of 19 and 23. Each participant sat in a comfortable upright position while an ECG recorded their heart beat. The HRV (SDNN) in males (0.059 ± 0.02) was not significantly different from that of females (0.055 ± 0.01; $p > 0.05$). This study shows no significant difference in the SDNN values of males and females, and therefore it can be concluded that there is no difference between the resting HRVs of male and female college-aged students.

EXAMINING THE RELATIONSHIP BETWEEN TONGUE RETRACTION RATE AND RELATIVE PREY MASS DURING TONGUE PREHENSION IN FROGS

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The use of the tongue to capture prey (tongue prehension) is an ability that evolved in several groups of animals (some lizards and most amphibians) to minimize injury from prey that usually fight back when captured. This mechanism involves a specialized tongue and associated bone and musculature needed to propel the tongue forward and retract the tongue quickly while adhered to a prey item. Different muscle types are involved in both the protraction and retraction phases of the sequence. Although much work has been done to examine the mechanics of this mode of feeding in chameleons, work in frogs is more limited. Moreover, previous research on frogs has mostly centered around tongue protraction, with less attention given to the retraction phase. We propose to examine the effects of prey size on the speed of tongue retraction in leopard frogs. This is an important step because frogs often prefer larger prey to maximize energetic intake, however, limitations on tongue retraction rates for larger prey may define prey size preferences and feeding behavior in frogs.

UPTAKE OF GENETIC COUNSELING AND OF GERMLINE GENETICE TESTING FOR PATIENTS WITH PACREATIC ADENOCARCINOMA

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Inherited cancer syndromes are responsible for up to 10% of pancreatic ductal adenocarcinoma (PDAC) cases. Genetic testing can identify genes responsible for an inherited predisposition to PDAC. This testing empowers patients and their families with the knowledge of PDAC risk as well as the risk of other cancers. In July 2018, the NCCN guidelines for management of PDAC were updated to include a recommendation that genetic testing be considered for all patients with PDAC, regardless of family history. We predicted that the updated guidelines would be associated with increased referrals for genetic counseling for patients with PDAC at seen UNMC. Using electronic medical record data from the past 5 years, the percentage of patients with PDAC seen at UNMC who were referred for genetic counseling and underwent testing were quantified; rates before and after guideline changes were compared. Patient referral rates went from 21.7% to 67.5% ($p<0.05$) after July 2018, while genetic testing rates went from 12.4% to 30.0% ($p<0.05$) during the same time period. These findings demonstrated that the updated NCCN guideline was indeed associated with higher rates of referral and testing. While this improvement is encouraging, it also represents an opportunity for significant improvement in delivery of care for PDAC patients at UNMC. Future studies should aim to understand physician and patient attitudes toward genetic testing. Educating patients, as well as simplifying genetics referral and consultation, may improve genetic counseling and testing rates.

ARTHROBACTER AURESCENS TC1 (AATC1)

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Arthrobacter aurescens TC1 (AATC1) is a gram-positive bacteria originally isolated from atrazine-rich soil samples in South Dakota. Interest in AATC1 is due to possible use in bioremediation of atrazine-contaminated groundwater. Developing these technologies requires quantitative growth kinetics data so that bioreactors can be designed for optimal operation. In this investigation, the growth rate of suspended cell AATC1 in the exponential growth phase was measured in a glucose minimal media that included atrazine. The effect of glucose concentration and atrazine concentration on growth rate was determined.

ARTHROBACTER AURESCENS TC1 BIOFILM GROWTH KINETICS FOR A GLUCOSE-BASED MINIMA MEDIA INCLUDING ATRAZINE

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Arthrobacter aurescens TC1 (AATC1) is a gram-positive, heterotrophic bacteria originally isolated from atrazine-rich soil samples in South Dakota. There is interest in using this species of bacteria in bioremediation technologies for removing atrazine from contaminated soils and water sources. In this investigation, the growth kinetics of AATC1 biofilms during the exponential growth stage was evaluated in a glucose minimal media including atrazine. Growth experiments were performed at constant temperatures and shear stress in each reactor experiment at varying concentrations of glucose. Biofilm accumulation was monitored over time from which a growth rate could be measured. An estimate of yield was also performed. This growth kinetics data can be used to facilitate the design of a fluidized bed reactor system for bioremediation of atrazine from groundwater.

DEVELOPMENT AND CHARACTERIZATION OF A POLYMERASE CHAIN REACTION ASSAY FOR THE 16S RIBOSOMAL GENE OF *BORRELIA BURGDORFERI*

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Lyme disease is the most common tick-borne human infection in the United States. It is a potentially debilitating, multi-systemic illness most frequently caused by the bacteria, *Borrelia burgdorferi.* The incidence of Lyme disease has nearly doubled since 2004, with 33,666 cases reported in 2018. Due to difficulties in diagnosing the disease, the CDC estimates the actual incidence may be 10 times higher, affecting 300,000 people annually. Recently the deer tick *Ixodes scapularis,* which is known to carry *B. burgdorferi* have been reported in Nebraska. In order to survey ticks found in Nebraska for the presence of *Borrelia burgdorferi*, we developed a polymerase chain reaction (PCR) assay targeting the bacterial 16S ribosomal RNA gene. The assay sensitivity as determined on purified *B. burgdorferi* DNA was 100 genome equivalents. Because the reported bacterial load for ticks carrying *Borrelia* species is between 2 x 10^2 and 4 x 10^5 organisms, the assay sensitivity was judged to be sufficient. To detect the presence of any interfering substances carried over from either the ticks or extraction methods, purified genomic DNA was spiked into ticks extracted by three different methods. In all cases, interference was observed that significantly decreased the assay sensitivity. We are currently examining several other extraction methods to improve the sensitivity. Since the presence of *Ixodes scapularis* and Lyme disease have been confirmed in Nebraska, improving the assay will be critical for developing an effective tool to compile a statewide risk map, indicating areas where infection with *Borrelia burgdorferi* is most likely to occur.

THE EFFECT OF PRAIRIE MANAGEMENT STRATEGIES ON MICROBIAL COMMUNITY DIVERSITY

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The soil microbial community plays a central role in regulating ecosystem properties such as plant community productivity, composition, and diversity. Despite their important role, the response to different land use and management strategies are not fully understood. We assessed microbial communities in 27 plots with 11 different management practices to determine changes in microbial community diversity. The samples we collected from Nine-Mile Prairie, in Lincoln, NE. DNA isolation was carried out following the manufacturer's instructions for the IBI Scientific Soil DNA Extraction kit, for each soil sample. The purified genomic DNA was then sent to the University of Minnesota

Genomics Center where the Illumina MiSeq cell was used for whole-genome sequencing in a 2x300 bp paired-end format. Data shows the diversity of the soil microbiome, for each plot, at Nine-Mile Prairie is extremely high (Shannon-Wiener Index = 4.435-5.204). When the different management practices were compared against each other the results showed low community similarity (Sorensen's Coefficient = 0.106), indicating that the diversity of the soil microbiome does change in response to management practice.

EFFECTS OF HIGH AND LOW ENERGY DIETS ON RUMINATION TIME IN BEEF CATTLE

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Rumination, or the re-chewing of long strands of fiber found in the diet of ruminant animals, has been thought to play a role in many vital aspects of beef animal health and performance. In particular, it is a vital process for balancing pH in the rumen, and therefore any disruption of normal rumination could cause serious health issues for a beef animal. Acidosis, which is a sudden decrease in the pH of the rumen, is one such health concern and is a common cause of death in many feedlot steers. High energy feedlot diets, which contain high amounts of corn and little fiber, are most likely what contribute to cases of Acidosis due to a lack of rumination. By comparing two diets, a standard high energy feedlot diet and a lower energy diet with more fiber, this study aimed to find the impact that diet has on beef cattle rumination time. Ultimately, the results show that cattle who consume a lower energy diet that contains higher amounts of fiber will ruminate significantly more than cattle that consume a higher energy diet. With this knowledge, feedlot producers should now be able to make better-informed management decisions in order to increase the health and overall productivity of their operation.

TAIL FLAGGING AS A POSSIBLE ANTI-PREDATOR BEHAVIOR IN SYLVILAGUS FLORIDANUS

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Tail flagging is a well-documented phenomenon in ungulates but not well studied in other animals, including rabbits. Some evidence supports it as an anti-predator behavior. The goal of the study is to investigate tail flagging as an anti-predator response in cottontail rabbits (Sylvilagus floridanus). We hypothesize that it functions to visually confuse the predator by displaying the white tail and subsequently hiding it after flight. Wild rabbits in eastern Nebraska were observed and approached by a human on foot at varying speeds. Flight distances were measured, and tail position was recorded throughout the flight using a numerical store. This study provides insight into predator-prey communication, specifically the role of prey signaling as anti-predator behaviors.

EXPRESSION OF AP2III-3 AFFECTS STAGE CONVERSION IN *TOXOPLASMA GONDII*

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The apicomplexan parasite *Toxoplasma gondii* undergoes life cycle switching to better survive under mammalian immune pressure. In its tachyzoite stage, *T. gondii* replicates quickly, causing an acute infection. After a few weeks, *T. gondii* transforms into a chronic, slow replicating stage that forms undetected cysts. Little is known about the mechanisms that activate its stage switching expression, but it is believed to be transcriptionally coordinated. Our work has suggested that the gene AP2III–3 regulates bradyzoite differentiation in *T. gondii*. Through gene cloning and different assays, we examine AP2III–3 and its ability to cause bradyzoite switching and cyst formation. We hope this adds to our limited knowledge of the bradyzoite stage and opens possibilities for potential treatments.

EVALUATION OF INTERNAL CORE TEMPERATURE WHEN EXERCISING IN COMPARISON TO BMI

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With exercise the body temperature rises due to the individual's heart rate increasing. Under normal and ideal conditions skin, blood vessels, and perspiration level help your body level ultimately adjust to the heat. Obesity, which can be indicated by a higher BMI, is generally associated with an individual being less physically fit and having a greater amount of adipose tissue. It is not associated with a reduced core body temperature; however, this study is aimed at determining if BMI plays a significant role in the change of temperature experienced while exercising. Research has shown that there is a significant rise in temperature while exercising but no studies have been done regarding the drop in temperature that occurs immediately before it rises. Sixteen students' internal core temperatures were monitored while they were completing the Harvard step test to simulate exercise and were compared/correlated with their BMI. This research showed that a persons' BMI does not affect the initial drop of internal core body temperature when exercising.

COLLEGIATE ACADEMY
CHEMISTRY AND PHYSICS

ALTERING THE STANDARD COSMOLOGY MODEL TO INCLUDE DARK MATTER DECAY

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The current standard cosmological model takes into account the energy densities of matter, dark matter, dark energy, and radiation. Decay of dark matter into radiation is not included in the standard model, though dark matter with a long lifetime against decay remains consistent with observations. In order to quantify limits on such a decay lifetime, I constructed a computational cosmological model that incorporates the decay of dark matter. I found that lifetimes of twenty billion years or longer are consistent with the observations taken from the Wilkinson Microwave Anisotropy Probe and the Planck Spacecraft that shape the standard model, while shorter lifetimes create wide variations from these observables of the standard model of cosmology.

PROTOTYPE READOUT SYSTEM SOFTWARE FOR THE STAR INTERLOCK SAFETY SYSTEM AT BROOKHAVEN NATIONAL LABORATORY.

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RHIC, located at BNL, collides nuclei at relativistic speeds to artificially recreate the initial conditions of the universe. The STAR Collaboration studies these collisions using a detector, the Solenoidal Tracker At RHIC. The Interlock Safety System is responsible for monitoring and displaying parameters in the STAR control room. These parameters include the temperature and pressure of the TPC gas mixture, the Oxygen Deficiency Hazard status, the Uninterruptable Power Supply status and the water cooling system status. If these parameters fall outside an accepted range, alarms will sound to notify the control room. The readout system and software allow for the shift operator to adjust detector variables while the experiment is running and thus prevent circumstances in which fires and explosions are likely. This project focuses on upgrades to the Interlock monitoring system. The current Interlock Readout monitor uses a VME to communicate with various STAR systems while the upgraded monitor uses a Programmable Logic Controller interfaced to a PC. Device support for the upgraded monitor has been written and compiled using a prototype input/output controller program to communicate to the new

readout PLC. Functionally, the existing and upgraded system will have the same capabilities. However, the new readout system will be easier to maintain and more easily updated to include, for example, additional safety signal outputs. In turn, this will result in a critical readout system prepared for future operations.

USING 3D PRINTED DEVICES TO ELUTE AND CONCENTRATE MESOPLASM FLORUM DNA MOLECULES.

Samantha Rau*, Alex Larsen, and Kristy L. Kounovsky-Shafer, Department of Chemistry, University of Nebraska – Kearney, Kearney, NE 68849.

In order to use physical mapping systems such as Nanocoding or Optical Mapping to discover variations among long DNA molecules, the molecules must be spread out to span a large enough region that there is enough unique information on either side of that region of the genome. The fragility of large DNA molecules prevents the molecules from remaining full length when routine molecular biology techniques are used to extract DNA from cells, so cells were embedded in an agarose matrix to protect the molecules during cell lysis. Once the cellular debris was removed, DNA molecules must be eluted from the insert. A 3D printed polyacrylamide (PLA) device was developed and affixed to a glass slide to elute and concentrate Mesoplasm florum DNA. An acrylamide gel was polymerized in the device to act as a "roadblock" to slow down the progression of DNA through the device. Using an electric field, DNA molecules were eluted from the agarose matrix into the solution and concentrated at the acrylamide roadblock. The concentration of DNA recovered at the interface between the "roadblock" and solution and DNA that remained within the agarose gel was measured to determine how effective the elution-concentration device was at concentrating DNA at the "roadblock".

ANALYZING LINEAR UNMIXING OF ENDOGENOUS FLUORESCENCE AND THE METABOLIC REDOX RATIO OF IN VIVO MICE.

Kelsey A. Jackson*, Connor J. Kalhorn, Molly S. Myers, George Varghese, and Dr. Michael G. Nichols, Department of Physics, Creighton University, Omaha, NE, 68178.

As cells become cancerous, their metabolism typically shifts towards higher glycolytic function, which should increase prevalence of reduced NADH and oxidizing flavoprotein (Fp). This results in changes in the cellular enzyme-bound NADH fraction as well as the relative composition of the endogenous fluorescence signal. Only the reduced form of NADH and the oxidized form of Fp are fluorescent. By measuring the redox ratio of NADH/Fp normalized intensity, changes in these coupled fluorescence signals can be amplified, serving as a sensitive technique for detecting shifts in cellular metabolism. However, challenges are introduced in measuring both of these intensities in a comparable way as dual excitation wavelength approaches introduce extra cost, complexity, and complications in calibration when imaging at depth in living tissues, while simultaneous single-wavelength excitation of these fluorophores necessitates linear unmixing. Furthermore, recent experiments suggest that other endogenous fluorophores in the skin, namely collagen and keratin, must also be considered in unmixing operators. Yet collagen fluorescence is unstable, dependent on the extent of cross linking and hence its mechanical stiffness. This complicates an otherwise routine linear unmixing calibration. Thus, alternative approaches for linearly unmixing multiple fluorophore signals from single wavelength studies that include structured fluorophores are proposed and will be discussed. My work aims to support the use of metabolic imaging as a sensitive diagnostic tool for the glycolytic shifts seen in cancer.

This study was made possible by grants from the National Institute of General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH. We also thank the NE-INBRE Program.

MEASURING PHOTOPRODUCTION OF THE Φ MESON IN ULTRA-PERIPHERAL COLLISIONS AT STAR

Ethan Wahle* and Johnny Zigmond, Creighton University, 2500 California Plaza, Omaha NE 68178

At Brookhaven National Laboratory's Relativistic Heavy Ion Collider (RHIC), the STAR collaboration has studied gold + gold ultra-peripheral ion collisions. The ions come close enough to interact electromagnetically without the nuclei physically colliding with one another, and the particles are travelling at nearly the speed of light. These interactions can produce a Φ Meson, which decays into a pair of Kaon Mesons (K+ and K-) roughly 50 percent of the time. We can potentially detect these daughters due to their charged states. Although other vector mesons have been studied at the Relativistic Heavy Ion Collider, the Φ Meson has not yet been measured. Ultra-peripheral collisions can occur coherently or incoherently. Coherent photoproduction of the phi meson, where the photon emitted from one nucleus interacts with the other nucleus as whole, has a larger cross section. However, Monte Carlo simulations have shown that incoherent production, where the photon interacts with an individual proton in the other nucleus, produces phi mesons which are much more likely to be reconstructed in our detector due to being produced with much greater momenta. We will use our results from a feasibility study using Monte Carlo simulations last year in order to choose selection criteria consistent with Kaons to identify the Kaon daughters and therefore the Φ Meson. This presentation will detail the analysis procedure used to select and identify Φ Mesons produced via photoproduction in these ultra-peripheral collisions at RHIC.

DEVELOPING AN ASSAY TO QUANTITATE SHORT-CHAIN FATTY ACIDS FROM BIOLOGICAL TISSUES.

Taylor Messer*, Danielle Tibbels, and Eric J. Haas, Department of Chemistry, Creighton University, Omaha, NE.

The abundance of short-chain fatty acids can be an indicator of an organism's overall health. This study describes development of an assay to determine relative and absolute quantities of select short-chain fatty acids (SCFAs) via gas chromatography-mass spectrometry (GC-MS). Unlike long-chain fatty acids that are normally converted to fatty acid methyl esters (FAMES), SCFAs are converted to higher molecular weight derivatives to facilitate gas-phase analysis. It is also desirable to increase sensitivity in order that SCFA levels in a single organism, such as a honeybee, can be easily and repeatably determined. Preliminary results of such experiments will be reported.

GLYPHOSATE DETERMINATION IN SOIL SAMPLES USING LC-MS.

Tara Buettner*, Kenneth Ernest, Annette C. Moser, Department of Chemistry, University of Nebraska at Kearney, NE 68849.

A method capable of detecting glyphosate and its major metabolite, aminomethylphosphonic acid (AMPA) was developed for the quantification of glyphosate in soil samples. Isotopically labeled glyphosate was added as an internal standard prior to extracting the samples. After extraction, a benchtop derivatization reaction with 9-flourenylmethyl-chloroformate (FMOC) was used to label the glyphosate and AMPA prior to LC-MS analysis. Glyphosate, isotopically labeled glyphosate, and AMPA were quantified separately based on m/z ratios of 392, 394, and 334 respectively using the positive ion mode. Detection limits of less than 0.1 mg/kg soil for both AMPA and glyphosate were obtained. Total glyphosate concentration is reported as the combination of these amounts and resulted in a linear calibration curve with a range of 0.1 – 20 mg/kg for spiked soil samples. Additional method development to obtain even lower limits of detection is currently in progress.

CATALYTIC HYDROGENATION OF ALKENES VS. ALKYNES WITH NANOPARTICLE PALLADIUM.

Grayson Huldin*, Giorgio Bacchin*, and Bruce Mattson, Department of Chemistry, Creighton University, Omaha, NE 68178.

Alkynes are hydrogenated to alkenes and alkenes to alkanes in the presence of Al-supported nanoparticle palladium catalyst (0.5%). Studies involving the hydrogenation of 1-butene 1-butyne, propene, propyne and ethene and ethyne are presented in the context of the relative rates of reaction. Our experiments observed the first few moments of the reaction between these hydrocarbons and hydrogen using our catalyst at ambient temperature. The rate was tracked by measuring hydrogen uptake vs. time.

A COMPUTATIONAL STUDY OF A ZINC PHTHALOCYANINE BENZOPERYLENETRIIMIDE CONJUJUGATE FOR SOLVENT DEPENDENT ULTRAFAST ENERGY VS. ELECTRON TRANSFER.

MJ Duffy*, Prof Dr. Paul A. Karr, Chemical Sciences, Wayne State College, Wayne, NE 68787, and S. Shao, Dr. H. B. Gobeze, C. Funk, B. Heine, Dr. V. Nesterov, Prof. Dr. F. D'Souza, Department of Chemistry, University of North Texas, Denton, TX 76203-5017 and Dr. V. Bandi Center for Cancer Research, National Cancer Institute, Frederick, MD 21702.

Employing various techniques a new series of donor–acceptor systems capable of exhibiting photo-induced charge separation have been designed, synthesized, and characterized. In order to gain insight into the molecular structure, molecular orbital distribution, and molecular orbital energies, the systems have been theoretically studied with the B3LYP Density Functional Theory (DFT) method combined with the 6-311G(d,p) split-valence polarized basis set. The structures presented have been optimized to a stationary point on the Born-Oppenheimer surface using the Gaussian 16 (G16) software suite running on the computing resources of The Holland Computing Center (HCC) operated by the University of Nebraska. The HOMO and LUMO visualizations were produced on a local pc using the GaussView 6.0 software package.

CHARACTERIZATION OF ULTRASONIC FLOWMETERS.

Ryan Ierna, Physics Department, Hastings College, Hastings, NE 68901.

Clamp-on ultrasonic flow meters utilize sensors attached to the exterior of a pipe to measure the flow of liquid within a pipe through the transit time method. The transit time analysis method uses data collected by two transducers, separated by less than a meter on the exterior of a pipe. A signal of a fixed frequency is sent across the pipe by the first transducer and bounced off the opposite side of the pipe to the second transducer. The received waveform is analyzed and used to calculate flow rate of the liquid. There are two types of transit time flow sensors: high Q and low Q. High Q transducers have a more powerful signal, but a smaller bandwidth than low Q sensors. Logically, low Q transducers have a lower power output but much wider bandwidth. A wider bandwidth enables low Q transducers to have a larger range of applications in comparison to high Q sensors. However, since low Q technology is relatively new and untested, it is not often used in industry. During this project, low Q transducers were characterized for many different pipe lengths, widths, thicknesses, and materials. This was accomplished via wave form analysis performed both quantitatively and qualitatively.

NANOPARTICAL PALLADIUM CATALYTIC HYDROGENATION OF CYCLOPROPANE.

Katie Cunningham*, Kenzie Enmeier, Kara Grossman, Grace Recker, Lydia Johnson*, and Bruce Mattson, Department of Chemistry, Creighton University, Omaha, NE 68178.

Cyclopropane undergoes hydrogenation and deuteration in the presence of a nanoparticle

palladium catalyst (0.5% on alumina) at elevated temperatures. In the case of deuteration, extensive and probably statistical D/H exchange takes place via the Horiuti-Polanyi mechanism through propyl[Pd] and pi-propene[Pd] intermediates. Cyclopropane can rearrange to propene at high temperatures if hydrogen is not present. Can this rearrangement occur at lower temperatures if the Pd catalyst is present? Is there evidence that D/H exchange occurs resulting in deuterated cyclopropane?

FLUX PINNING SUPERCONDUCTORS TO CREATE A MAGLEV EFFECT.

Travis Kleeb, Physics Department, Hastings College, Hastings, NE 68901.

Type 1 Superconductors are special types of materials that exhibit a strange phenomenon explained by the Meissner effect. When a type 1 superconductor is cooled down to its critical temperature, the material will expel all magnetic fields from its interior. Type 2 superconductors exhibit a partial Meissner effect and are able to allow small amounts of magnetic flux to pass through its interior within flux tubes. The number of flux tubes is dependent on the strength of the magnetic field. By manipulating the strength of the magnetic field and consequently the number of flux tubes, it is possible to levitate a superconductor at a fixed distance from a magnet and at a fixed orientation. This effect is called quantum locking or flux pinning. This study will focus on flux pinning and the its applications. During this research project, the maximum separation between the superconductors and the magnets creating the magnetic field was determined and the maximum load the superconductors could support was measured.

DESIGN, CONSTRUCTION AND TESTING OF AN ULTRA-OPEN ACOUSTIC METAMATERIAL.

Joseph Jahn, Physics Department, Hastings College, Hastings, NE 68901.

An acoustic metamaterial (AMM) is a subwavelength material that acquires its acoustic properties predominantly from its structure rather than the properties of its constitutive materials. Originally conceived to achieve greater sound isolation than traditional materials of comparable mass and density could provide, AMMs have been developed with several interesting properties such as negative refractive index and super resolution. This study focuses on an ultra-open AMM. The ultra-open AMM maximizes the open space of the material allowing for forced ventilation at the expense of the width of the stopband. Despite this disadvantage, the material's attenuation peaks are harmonic in nature, thus making it well suited for attenuating mechanical noise of a predetermined frequency. During this project an ultra-open AMM was constructed and its acoustic properties were measured. This type of material may provide a lighter, smaller, less expensive, and less restrictive noise control option for fans, mechanical exhaust, and other situations where airflow is critical.

LIPID COMPOSITION OF THE SQUASH BUG, *ANASA TRISTIS*.

Eric Tran, Odelia Moon, and Eric J. Haas, Department of Chemistry, Creighton University, Omaha, NE 68178.

Lipids play an important role in the immune response of insects to a pathogenic challenge. In an effort to better characterize utilization of fatty acids to produce immune mediators, we are cataloging the lipid composition of the squash bug, *Anasa tristis.* This pest insect has an important agricultural impact throughout the Midwest. Relative quantities of key fatty acids in both phospholipid and neutral lipid fractions are being determined using gas chromatography-mass spectrometry (GC-MS). Fatty acids of principal interest include palmitic (16:0), palmitoleic (16:1), stearic (18:0), oleic (18:1), and linoleic (18:2) acids. This catalog of whole-insect lipids will function as a reference for further studies including insects undergoing pathogenic challenge, those treated with inhibitors of the immune response, and analyses of individual organs of the insect.

USE OF PIEZOELECTRIC ACTUATORS FOR THE CONTROL OF TRAILING EDGE HELICOPTER BLADE FLAPS.

Melissa Hinrichs, Physics Department, Hastings College, Hastings, NE 68901.

Helicopter design research is commonly concerned with increasing efficiency and reducing noise. One way to accomplish these goals is to modify the rotor profile to reduce vibrations. With ideal active vibration reduction, each blade can be adjusted as the rotor spins to create the optimal airflow. During this research project, a piezoelectric bender actuator was used to move a trailing edge flap and effectively change the shape of the blade during rotation in order to reduce turbulence for the blade that followed. Properties of the piezoelectric bender actuators were investigated by measuring the maximum displacement and comparing to the manufacturer's specified value. In addition, the effect of flap movement on airflow was observed inside a Flotek 360 wind tunnel. The system was then applied to a functional rotor to measure the change in thrust generated and vibration of the rotor.

OBSERVATION AND PHOTOMETRIC ANALYSIS OF A RR LAYRAE STAR.

Parker Grant, Physics Department, Hastings College, Hastings, NE 68901.

RR Lyrae variables are periodic variable stars usually found in globular clusters. They are used as standard candles to measure extragalactic distances. This class of variable star is named after the prototype and brightest example, RR Lyrae. RR Lyrae variables are intrinsic variables. These are stars whose luminosity changes due to changes within the star. During this project, observations of one RR Lyrae variable, the RR Gem star, were made. The process used when analyzing observations is known as photometric analysis. Photometric analysis is a technique used in astronomy that is concerned with measuring the flux or intensity of light radiated by astronomical objects. This light is measured through a telescope using a photometer, often made using electronic devices such as a CCD camera. When calibrated against standard stars of known intensity and color, photometers can measure the brightness or apparent magnitude of celestial objects. Based on the apparent magnitude, an estimate of the distance to the star can be made.

OBSERVATION OF FORMATION OF XENON CLATHRATE HYDRATE USING RAMAN MICROSCOPIC AND RAMAN ANALYSIS

Avinash Kumar Both and Chin Li Cheung, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68512

Gas clathrate hydrates are non-stoichiometric crystalline solids composed of molecular-sized water cages with encapsulated gas molecules. A wide range of different gas molecules such as xenon, methane, carbon dioxide (CO2) and hydrogen has been shown to form gas clathrate hydrates. Research on xenon gas clathrate hydrates has received intense attention due to the inert nature of xenon which helps in understanding the nucleation of gas clathrate hydrates. In this talk, we will discuss our observation of xenon clathrate hydrate structures and the basic mechanism behind the formation of these unique xenon clathrate hydrates under specific laboratory conditions. We report our observation of the growth of xenon clathrate hydrate under moderate pressure (50 psi to 60 psi) of xenon and low temperature (-10 °C to 0 °C). The composition and molecular structures of the observed structures were indirectly inferred from the vibration signatures of water in the Raman spectra of these materials. A growth mechanism based on the "bubbling" xenon from the formed xenon clathrate hydrate substrate was postulated. We expect that our findings can improve the understanding of phase boundaries of gas clathrate hydrates and the nucleation of different gas clathrate hydrate structures.

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FRIEND OF SCIENCE AWARD TO TIFFANY HENG-MOSS

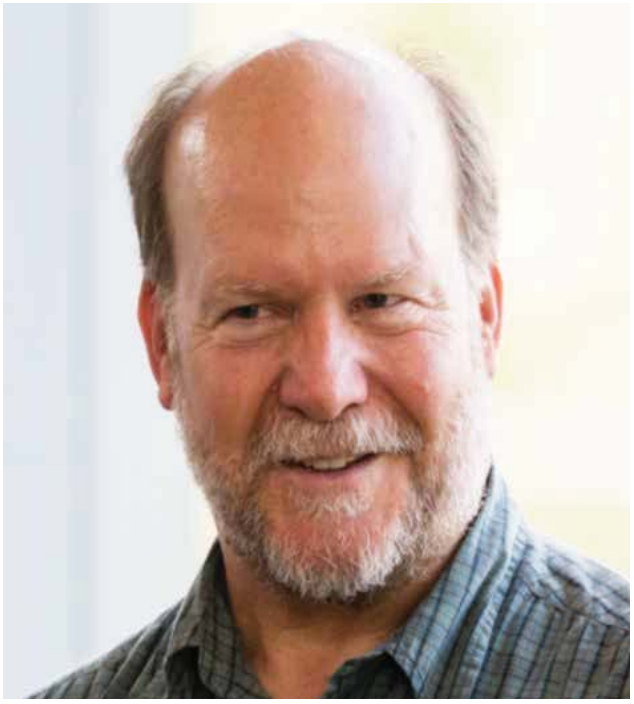
Dr. Tiffany Heng-Moss currently serves as Dean for the College of Agricultural Sciences and Natural Resources (CASNR). Since joining the University of Nebraska-Lincoln (UNL) faculty in 2001, Dr. Heng-Moss has developed and taught both undergraduate and graduate courses along with providing leadership for the development and implementation of multiple academic degree programs in the College of Agricultural Sciences and Natural Resources. She is passionate about teaching; focuses on student success; is excited about agriculture and science; and motivates students to want to learn.

Dr. Heng-Moss currently provides leadership for NebraskaSCIENCE, which is a partnership initiative among the Colleges of Arts and Sciences, Education and Human Sciences, and Agricultural Sciences and Natural Resources; contributes to the Institute of Agriculture and Natural Resources' (IANR) science literacy program that is focused on providing education platforms for the continuum of learners in resilient food, energy, water and societal systems; has facilitated the development of the undergraduate Life Sciences curriculum at the University of Nebraska-Lincoln; and has partnered with Nebraska schools to offer food, energy, and water systems experiential learning opportunities to K-12 students and educators.

In her role as dean, Heng-Moss has led the development of the college's graduate education framework, college-level attributes, a smart enrollment growth framework, and the first education compact in Nebraska. She has authored/co-authored over 85 refereed teaching and research articles and secured over $50 million in teaching/outreach grants and $9 million in research funds.

Heng-Moss has received several teaching awards, including the USDA National Award for Excellence in College and University Teaching in the Food and Agricultural Sciences, the Entomological Society of America Distinguished Achievement Award, Gamma Sigma Delta Teaching Award, and the University of Nebraska Outstanding Teaching and Instructional Creativity Award (OTICA).

FRIEND OF SCIENCE AWARD TO DAVID HARWOOD



Dr. David Harwood is a Professor and TM and EE Stout Chair of Stratigraphy in the Department of Earth and Atmospheric Sciences (EAS) at the University of Nebraska-Lincoln, and has been in service there since 1989. He graduated with a Ph.D. in Geology and Mineralogy in 1986 from The Ohio State University, a M.S. in Geology in 1982 from Florida State University, and a B.S. in Geology in 1980 from the University of Akron. Harwood's main research interests involve reconstructing the paleoenvironmental and paleoclimatic history of Antarctica and the Southern Ocean through paleontological and stratigraphic studies of sedimentary rock sequences and drill cores. His specific expertise is as a micropaleontologist and stratigrapher, studying Cretaceous and Cenozoic diatom microfossils and applying them in biostratigraphy and paleoecology. He has been to Antarctica and the Southern Ocean 18 times, leading small tent-based remote field teams, as well as large international drilling projects like the Antarctic Geological Drilling Program (ANDRILL), of which he was the U.S. Principal Investigator. He now manages the Hot Water Drilling Program at UNL, which drilled more than 1000 meters below the West Antarctic Ice Sheet in 2018 to provide access into Mercer Subglacial Lake. Dr. Harwood teaches a general education course entitled 'Frontiers in Antarctic Geosciences', as well as courses in 'Micropaleontology' and 'Siliceous Phytoplankton Paleontology'. Since 2004, Harwood has led an impactful summer professional development experience for science teachers in conjunction with NMSSI, a 16-day inquiry-based geoscience field course across WY, NE, SD, where teachers discovery the history of the Rocky Mountains and sharpen their classroom skills. Harwood has been the recipient of numerous awards in recognition of his commitment to science and education in Nebraska including: Catalyst Award from the Nebraska Association of Teachers of Science (2015); Distinguished Teaching Award, College of Arts & Sciences (CAS), UNL (2019); Lawson Award Dept. EAS, UNL (2015) and Coffman Excellence in Geology Award from EAS, UNL, was recognized as a NSF Presidential Young Investigator (1991-1996), and is presently a Dean's Fellow of the College of Arts & Sciences Teaching Academy, UNL.

Author Index

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z